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Mosquito News

Published Quarterly
by the
AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

VOLUME 15 SEPTEMBER, 1955 NUMBER 3

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12th Annual Meeting of the American Mosquito Control Association, Beaumont, Texas, February 5–8, 1956.

MOSQUITO NEWS

Official Publication of the American Mosquito Control Association, Inc.

Editorial Office, State Education Building, Albany, N. Y.

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Published by

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

Printed by

Boyd Printing Company, Inc., Albany, N. Y.

A quarterly journal published on the 20th of March, June, September and December. Devoted to the improvement and the sound extension of mosquito control and related work as a vital public health service.

SUBSCRIPTION RATES

$5.00 per Year (U. S. money), Single Copies, $1.75
Mailed without charge to members of the Association.

MEMBERSHIP DUES—$5.00

BUSINESS COMMUNICATIONS

Communications relating to editorial matters and manuscripts submitted for publication in MOSQUITO NEWS should be addressed to Donald L. Collins, Editor, MOSQUITO NEWS, New York State Museum, Albany, New York.

F. P. CREADON, Advertising Manager, Desplaines Valley Mosquito Abatement Dist., 8130 Ogden Ave., Lyons, Ill.

Communications relating to subscriptions to MOSQUITO NEWS, Membership in the American Mosquito Control Association, and other association matters should be addressed to T. G. Raley, Executive Secretary, American Mosquito Control Association, P. O. Box 278, Selma, Calif. Changes of address should reach the Secretary before the first of the month of publication.

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ARTICLES

FIELD STUDIES WITH WATER-SOLUBLE INSECTICIDES FOR THE CONTROL OF MOSQUITO LARVAE IN CALIFORNIA PASTURES [1]

JAMES B. GAHAN
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AND
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California Department of Public Health, Bureau of Vector Control

In laboratory studies Bayer L 13/59 (*O,O*-dimethyl 2,2,2-trichloro-l-hydroxyethylphosphonate) was found to be outstanding among various mosquito larvicides tested in water solutions (Gahan *et al.* 1955b). It is completely effective against fourth-instar larvae of *Anopheles quadrimaculatus* Say at about 0.5 p.p.m. It is more soluble in water than most insecticides, and 4 gallons of a saturated solution contain enough insecticide to treat 1,000,000 gallons of water. Indoor storage for 20 weeks and outdoor exposure to sunlight 5 days each week for 4 weeks had no deleterious effect on the toxicity of the compound in solution in distilled water. Since this information was published, Shell OS 2046 (dimethyl 1-carbomethoxy-1-propen-2-yl phosphate) has been found to be slightly more toxic than Bayer L 13/59, and it is completely miscible in water.

In April and May of 1955 field studies were made in California in the vicinity of Visalia and Tulare, to evaluate these two compounds as mosquito larvicides in irrigated pastures. As the rainfall in this section of the State is insufficient to keep pasture grass alive, the fields are flooded every 10 days or 2 weeks with water from wells or large irrigation ditches. The water is introduced at the highest level and gradually works its way through the vegetation to the lower end of the field. In some pastures the excess water flows into a ditch that removes it from the premises, but in others no provision is made for disposing of this surplus, which stands until it is absorbed or evaporates. As the soil is heavy and does not readily absorb water, portions of some fields remain covered for more than a week.

These conditions create excellent habitats for tremendous populations of mosquitoes. Ecological studies conducted by S. Davis and R. C. Husbands [2] in pasture areas of this type have demonstrated that 80 to 90 percent of the mosquitoes are *Aedes nigromaculis* (Ludl.), generally about 5 percent are *Aedes dorsalis* (Meig.), and the remainder are largely *Culex tarsalis* Coq., its density depending upon the age and condition of the pasture. According to W. Donald Murray and Marvin C. Kramer (personal communication), the infestations normally present in the fields used for these studies were at least 95 percent *A. nigromaculis*.

EXPERIMENTAL PROCEDURE. Pastures on five farms were used in these studies. Farmers in this part of California usually divide their pastures into sections 25 to 50 feet wide by constructing longitudinal levees, or borders, the full length of the

[1] This work was conducted in part under funds allotted by the Department of the Army to the Entomology Research Branch. W. Donald Murray and Marvin C. Kramer, of the Delta and Tulare Mosquito Abatement Districts, respectively, and R. C. Husbands, of the Bureau of Vector Control, assisted in these studies. The Chemagro Corporation supplied the Bayer L 13/59 and the Shell Development Company the Shell OS 2046.

[2] Progress report on irrigation practices and mosquito production 1954. Cooperative study by U.S.D.A., Soil and Water Conservation Research Branch; California Department of Public Health, Bureau of Vector Control; and California Mosquito Control Association, Inc.

fields. These sections are commonly called checks, and each plot used for treatment consisted of a single check. Since there were from 6 to 20 checks in a field, obtaining untreated plots for comparative purposes was no problem.

To insure adequate water to support mosquito breeding, an unusually large quantity was introduced into all the plots. In practical mosquito-control operations less chemical would be needed than was used in these tests.

It was necessary to know the rate of water flow while the irrigation was in progress. If the pump was calibrated, no additional measurement was made, but if its capacity was not known, a circular dam, 6 to 8 inches high, was built around the water-line opening and the water entered the plots through a Parshall flume set in the wall of the dam (Fig. 1). If this apparatus was maintained in a level position, the water flow could be determined from the head pressure behind the throat of the flume. The flow rate was controlled by valves in the water line.

The chemicals were added to the water with the automatic applicator described by Gahan *et al.* (1955a). This device, attached to a 55-gallon drum, was set up at the point of greatest turbulence where the water entered the field. In the fields flooded from wells, the insecticides were introduced as the water bubbled from the valve or collected in the pool formed by the circular dam. In the field flooded from an irrigation ditch, they were applied near the point where the water entered a flume. Because of the range in the rates of water flow and the rates of application of the insecticide, the concentration of the solution dispensed from the reservoir ranged from 0.028 to 2.6 percent.

In large-scale operations this applicator

FIG. 1. Introducing water-soluble insecticides into irrigation water that enters a pasture through a Parshall flume.

would probably be located at the irrigation pump and discharge into the large standpipe, if one is used, or directly ahead of the discharge pipe to treat all the water delivered to the fields. Where ditch irrigation is employed, the apparatus could be located at a large Parshall flume, or weir, that would be needed in the main ditch to measure the rate of flow. In this way large areas could be treated from a single source, and advantage could be taken of the turbulence that occurs at such places to get good agitation.

Initial applications were made on the Simoes farm with Bayer L 13/59 in three concentrations in each of two pastures that consistently had been heavy breeders. The plots were 250 to 400 feet long and 40 feet wide. Because the porosity of the soil was not uniform, the amount of water introduced in the different plots ranged between 78,500 and 131,200 gallons per acre. From 0.112 to 0.118 pound of L 13/59 was applied per acre to give 0.1 p.p.m., from 0.73 to 0.88 pound to give 1 p.p.m., and 3.08 to 3.18 pounds to give 3 p.p.m.

To determine whether a soluble insecticide would remain effective after the treated water had traveled a long distance through the fields, on two farms a plot approximately a half-mile long was treated with L 13/59 at 1 p.p.m. On the Grant farm 825,200 gallons of water were applied, which gave a dosage of 2 pounds of the insecticide per acre, and on the Gray farm 162,000 gallons of water, which gave 0.86 pound of insecticide per acre.

On two farms Shell OS 2046 was used to give a concentration of 1 p.p.m. A plot 320 by 30 feet on the Jennings farm and one 720 by 27 feet on the Canada farm were treated with 0.71 and 1.2 pounds per acre, respectively. On the Canada farm an irrigation ditch was used as the source of water. For this test the Parshall flume was set in the bank of the ditch and the measured water flowed into the field through a funnel-like, constricted area made with two dirt walls 4 to 6 inches high. With this arrangement the hydrostatic pressure was very difficult to control, and the flow did not remain constant for more than 15 or 20 minutes. It is believed that the amount of chemical that this plot actually received was somewhat greater than 1 p.p.m.

The effectiveness of the treatments was determined by dipping for larvae in the treated and nearby untreated areas. The number of dips ranged from 20 to 150 per plot, according to the time available and the amount of water present. Counts were made on the first and second days after flooding, and sometimes also on the third day. A percentage control figure was obtained on the supposition that the larval densities in treated and untreated areas would have been identical had no insecticide been applied. In addition to these field observations, two 1-quart samples of water were removed from the lower end of each treated and untreated plot, and partially grown *Aedes* larvae collected from other fields were exposed in them to determine the knockdown and 24-hour mortality.

RESULTS. Counts of Larvae Obtained by Dipping. As shown in table 1, all but two of the treated plots were completely free of mosquito larvae. In one of the plots treated with L 13/59 at 1 p.p.m., 3 larvae were found in 40 dips on the following day, but since the same number of dips on each of the next 2 days produced no larvae, it is probable that this application also eventually gave 100 percent control. Larvae were never found in the other three plots receiving this concentration, including those a half-mile long. Some control was indicated with L 13/59 at 0.1 p.p.m., but this concentration was definitely inferior to the others.

At the Simoes farm the infestations in the untreated plots were sufficiently high to demonstrate clearly that the insecticide applications were successful. On all the other farms the larval density was low and the reduction in numbers in the treated plots, though complete, was less impressive. The unusually rainy and cold weather during the 2 weeks prior to these tests may explain in part the low populations encountered.

TABLE 1.—Control of *Aedes* larvae in pastures treated with Bayer L 13/59 and Shell OS 2046, as determined by larval counts

Farm	Parts per million of insecticide [1]	Number of dips		Number of Larvae per dip		Percent control
		Treated plots	Untreated plots	Treated plots	Untreated plots	
			Bayer L 13/59			
Simoes	3	220	120	0	70	100
	1	220	120	0.01	10	99.9
	0.1	200	160	5	19	74
Grant	1	200	350	0	0.14	100
Gray	1	200	200	0	.25	100
			Shell OS 2046			
Jennings	1	100	100	0	.09	100
Canada	1	100	100	0	.19	100

[1] Two replicates at each concentration on Simoes farm, one on the others.

Toxicity of Water Samples. The first water samples were removed from the plots on the second day after the insecticide was applied, and larvae were introduced into them immediately. From 44 to 100 larvae were introduced per sample. All treatments caused 100 percent mortality within 24 hours. The knockdown obtained with water from the Grant and Gray farms, collected approximately a half-mile from the point at which L 13/59 was introduced, was as rapid as that with water from the much smaller field on the Simoes farm, being complete in 2–3 hours. These results show that water containing this insecticide in solution can flow considerable distances without losing its toxicity. At 0.1 p.p.m. it was slow in action, as only a small percentage of the insects were down after 10 hours. OS 2046 caused total knockdown in 1 hour in the water from the Canada farm, but more than 16 hours were required in the sample from the Jennings farm.

Lack of Residual Toxicity of Bayer L 13/59. The water samples collected on the Simoes and Grant farms were held until the eighth day, at which time others were taken from the same locations and comparative toxicity tests were run against second- and third-instar *Aedes* larvae. The samples taken on the second day again caused 100 percent mortality, whereas one of those collected on the eighth day caused 34 percent mortality and the others caused none.

After the plots on the Simoes farm had dried, 23 days after the first flooding, they were reflooded with untreated water. Counts made on the first and second days after the fresh water was added showed larvae to be present in all sections of the field and more numerous in the places that previously had been treated with L 13/59. The Delta Mosquito Abatement District had sprayed the untreated plots with parathion at the rate of 0.1 pound per acre when the larvae from the previous brood reached the fourth instar. These observations showed that L 13/59 did not have any residual toxicity. Phosphorus insecticides have been known to be unstable in an alkaline medium, and it is likely the high alkali content of the soil of the these fields had a deleterious effect on the insecticides.

SUMMARY. Field tests were made in the vicinity of Visalia and Tulare, Calif., to evaluate the effectiveness of water solutions of the phosphorus compounds Bayer L 13/59 and Shell OS 2046 as larvicides for the control of mosquitoes in irrigated pastures. An automatic applicator was used to introduce the chemical into the water as it entered the fields.

Bayer L 13/59 at concentrations of 3 and 1 p.p.m. and Shell OS 2046 at 1 p.p.m. gave 99.9 to 100 percent control. Incom-

plete control was obtained with Bayer L 13/59 at 0.1 p.p.m.

Tests with *Aedes* larvae in water samples from the plots showed that the treated water lost none of its toxicity while flowing as much as ½ mile through the fields. Samples taken 2 days after application of Bayer L 13/59 were completely effective, but others collected on the eighth day were ineffective. There was no control in treated plots that were dried and reflooded with untreated water. Lack of residual toxicity may be due to the alkaline soil in the fields that were treated.

References Cited

GAHAN, J. B., LABRECQUE, G. C., and BOWEN, C. V. 1955a. An applicator for adding chemicals to flowing water at uniform rates. *Mosquito News* 15(3):143–147.

GAHAN, J. B., LABRECQUE, G. C., and NOE, J. R. 1955b. Laboratory studies with water-soluble insecticides for the control of mosquito larvae. N. J. Mosquito Extermin. Assoc. Proc. (In press.)

AN APPLICATOR FOR ADDING CHEMICALS TO FLOWING WATER AT UNIFORM RATES[1]

J. B. GAHAN, G. C. LABRECQUE, AND C. V. BOWEN
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A study of water-soluble insecticides for the control of mosquito larvae in irrigated fields focused attention on the need for an improved applicator for adding chemicals to flowing water.

Wisecup *et al.* (1946) tested various valves, pumps, and siphons for introducing DDT emulsions into rice-field water, but found all needed constant attention for uniform operation. They finally placed primary dependence on drip cans equipped with a metered valve from an oil heating stove, and maintained a constant vigil so the flow could be adjusted as needed.

Knowles and Fisk (1945), who worked concurrently on the same problem, favored a pump ordinarily used for chlorination to transfer water into an airtight bottle and force the displaced air into another airtight bottle that held a DDT emulsion. As the air in the latter bottle increased, the larvicide was ejected through an outlet tube.

Geib and Smith (1949) described a siphon attached to a 50-gallon drum to introduce DDT emulsions into irrigation water in California. The siphon consisted of a small rubber hose and copper tube with a glass metering tip that had an orifice large enough to permit 50 gallons of the emulsion to flow through in 24 hours at about 3 feet of head. The tip was suspended in the irrigation stream. They reported satisfactory operation with this device, but felt that further work was needed on refining the metering tip and on developing an apparatus that would maintain a constant head.

Lt. Comdr. F. R. DuChanois and other U. S. Navy personnel (personal communication) solved the problem of maintaining a constant head by directing the liquid from a reservoir tank into a 5-gallon auxiliary tank in which a steady level was maintained with a float valve similar to those used in toilet flush tanks. The insecticide preparations were released from this auxiliary tank at a uniform rate through a sight needle valve and tube attached near the base of the container.

Maintenance of a constant head is essential to an even discharge from dispensers with a gravity feed, as slight variations in the weight of the water column affect the flow rate. When the water level declines, as it did with some of the dispensers mentioned, the output gradually slows down and may stop completely unless frequent adjustments are made.

The apparatus described in this paper

[1] This work was conducted at the Orlando, Fla., laboratory of the Entomology Research Branch under funds allotted by the Department of the Army.

furnishes a simple means of maintaining a constant head on the liquid column and an even application rate. There are no moving parts, and no outside source of power is required. The unit is compact and rigid; so will not be easily broken. After the discharge has been started, no further attention is required until the supply of chemical is exhausted.

Essentially, the applicator consists of a balancing well, made of metal pipe, with a small hole in the bottom through which the liquid escapes. Near the top of the well is a lateral opening into a pipe to an airtight reservoir. The applicator starts to function when a valve between the well and the reservoir is opened and the well starts to fill. When the liquid level in the well is high enough to cover the lateral opening, the air supply to the reservoir is cut off, a vacuum forms in the reservoir, and the flow ceases. As soon as sufficient liquid escapes from the bottom of the well to uncover part of the lateral opening, air enters the reservoir and displaces sufficient liquid to seal the opening again; so the level in the well changes very little.

A satisfactory applicator can be constructed from pieces of galvanized iron pipe, a brass shut-off valve or stopcock, and an insecticide-sprayer nozzle. The parts can be purchased for $6 to $8 in any hardware store, and no special knowledge of mechanics is needed to put them together. A detailed drawing of the assembled apparatus is shown in Figure 1. A piece of 2-inch pipe (*C*) is capped on one end (*E*) and attached to a 2- by 2- by ¾-inch tee joint (*B*) on the other end. A threaded hole in the center of the cap permits the attachment of short lengths of ¼-inch pipe (*D*), both inside and outside of the balancing well that has been formed. A compressed-air sprayer nozzle (*F*), with the whirl plate removed, is attached to the outside piece of ¼-inch pipe, and the inside piece is covered with copper screening to prevent dirt particles from clogging the nozzle. Two ¾- by 2-inch galvanized iron pipe nipples (*G*) are screwed into the openings of a ¾-inch brass gate valve (*H*), and this control assembly serves as the junction between the tee joint and the reservoir (*I*).

While the applicator is in operation, this assembly must be kept approximately level. If the end of the reservoir to which the applicator is attached is higher than the other end, air cannot enter the reservoir and the apparatus ceases to function. An additional piece of 2-inch pipe (*A*) above the tee joint serves as a stack and gives extra depth to the well to prevent overflow in case an unusually large amount of liquid is discharged from the reservoir at one time.

A 55-gallon metal drum with a lacquered interior is a suitable reservoir. The interior must be coated to prevent rusting. The drum is laid on its side in a rack or stand with the ¾-inch opening in the head down. The applicator is attached to this opening with the well in a perpendicular position. The drum is filled through the 2-inch hole (Fig. 2). Filling will be simplified if this hole is on the top while the drum is in the rack, but containers with both openings in the head are usable. A good gasket will be needed beneath the cap covering this hole, as it must be airtight. The drum must be shaded, as sunshine falling on the uncovered metal causes the air inside to expand and push an excess of liquid into the stack of the applicator, which temporarily raises the head pressure and application rate. A cover consisting of a flat board 2 by 3½ feet has been used successfully to prevent this sudden rise in temperature and the resultant excess flow. Two strips of wood nailed 6 inches apart to the underside of the board near the center will prevent tipping. A covering of asbestos or wet sacks will accomplish the same purpose.

If the reservoir is only partially filled at the time it is closed, 1 or 2 minutes may be required for the vacuum to form. During this period the discharge rate is uncontrolled, and the well may flood unless a stack high enough to equalize the head pressure in the applicator and reservoir is attached to the open end of the tee joint. It can be removed after the vacuum forms and the water level again falls below

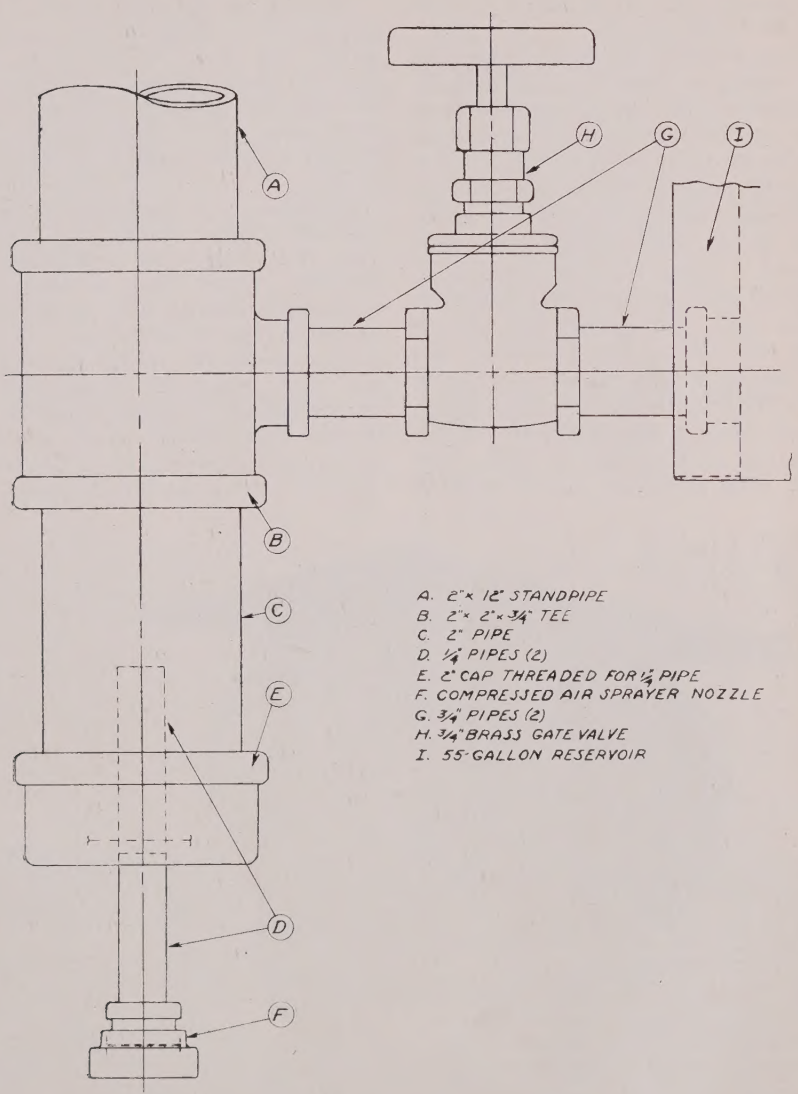

FIG. 1. An applicator for adding chemicals to moving water.

the top edge of the tee joint. When the tank is full, the vacuum forms within a few seconds after the apparatus is started and no flooding occurs.

There are three easy ways of controlling the amount of chemical applied with the applicator. The simplest method is to vary the concentration of the formulation used in the reservoir. The liquid used as a diluent must be clean, as any solid material may cause stoppage in the nozzle. If a nozzle with interchangeable disks is used, a range of delivery rates can be obtained with a series of disks of different orifice sizes. The authors have successfully used rates of flow between 50 and 400 ml. per minute, but others are possible. The third method consists of changing the head on the column of water by increasing or decreasing the depth of the well. This adjustment can be made by using nipples of different lengths between the tee joint and the nozzle.

Although this apparatus was developed primarily for applying insecticides to irrigation water, it can be used to add any liquid to moving water. Examples are the application of soluble fertilizers or pH adjusters to irrigated fields and the chlorination of water supplies or swimming pools.

SUMMARY. An apparatus that automatically applies chemicals to moving water at a uniform rate is described. It furnishes a simple means of maintaining a constant hydrostatic head on the liquid column in a gravity feed device. The applicator consists of a well, made of metal pipe, from which the liquid gradually escapes through a sprayer nozzle in the bottom. Near the top of the well is a lateral opening that connects to an airtight reservoir. When the liquid level in the

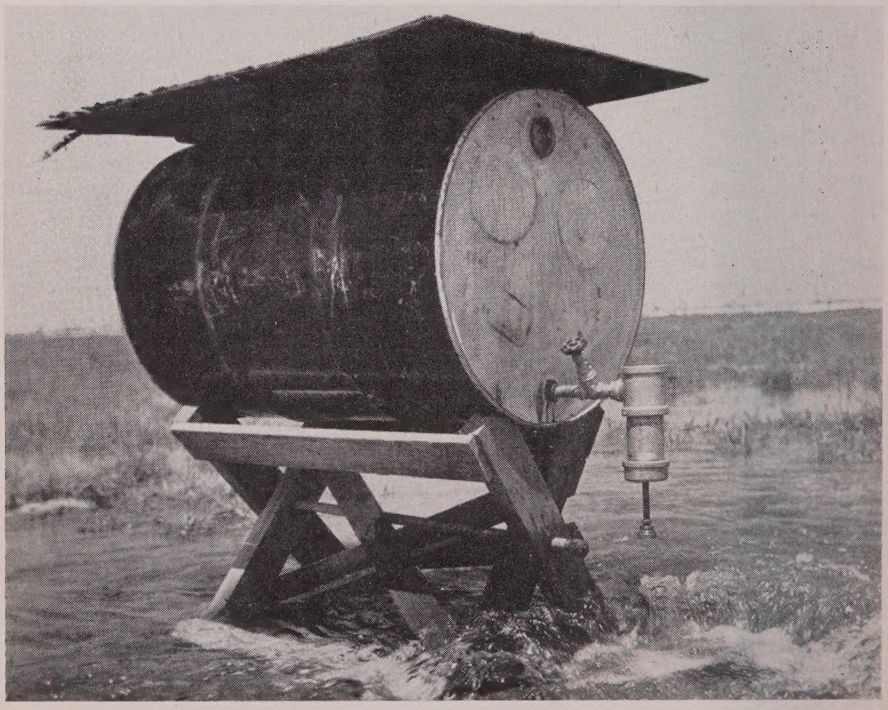

FIG. 2. Applicator in operation in an irrigated pasture infested with mosquitoes.

well is high enough to cover the lateral opening, the air supply to the reservoir is cut off, a vacuum forms, and the flow ceases. As soon as sufficient liquid escapes from the bottom of the well to uncover part of the lateral opening, air enters the reservoir and displaces sufficient liquid to seal the opening again. A 55-gallon metal drum with a lacquered interior is a convenient reservoir. The apparatus was developed primarily for applying insecticides to irrigation water, but also has other uses.

Literature Cited

Geib, A. F., and Smith, G. F. 1949. A preliminary report on the use of DDT emulsible concentrate by a modified drip method for *Aedes* control. *Mosquito News* 9(1):10–13.

Knowles, F. L., and Fisk, F. W. 1945. DDT water emulsions in rice fields as a method of controlling larvae of *Anopheles quadrimaculatus* and other mosquitoes. U. S. Pub. Health Serv. Rpt. 60(35):1005–19.

Wisecup, C. B., Brothers, W. C., Eide, P. M., and Deonier, C. C. 1946. DDT emulsion applied to rice-field water to control mosquitoes. Jour. Econ. Ent. 39(1):52–55.

A REVISED PROCEDURE FOR MAKING RAPID PERMANENT MOUNTS OF MOSQUITO LARVAE

GEORGE J. BURTON, Ph.D.[1]

United States Public Health Service

In two previous articles (1953, 1954) various procedures for making permanent mounts of mosquito eggs, larvae, pupae, and adults were described. In an area of high humidity such as the coast of Liberia, some of these methods did not produce satisfactory results. It was also found by experimentation that storage or dehydration in 70 per cent alcohol was entirely unnecessary. Specimens kept too long in beechwood creosote turned quite dark and were unsatisfactory for mounting. A revised procedure was determined as follows:

(1) Kill larva in hot water (preferably) or in 95 per cent alcohol.
(2) Dehydrate in 95 per cent alcohol for 2 hours.
(3) Clear in beechwood creosote for no more than 10 minutes.
(4) Transfer to xylene or toluene for 30 seconds to 1 minute. Swish specimen around gently.
(5) Mount in Permount, either the xylene or toluene mixture.

Permount dried more rapidly than any of the other mounting media previously described, and gave no difficulty with formation of a whitish precipitate around the specimen, provided step (4) was followed. Xylene may be used even if the Permount is made with toluene, and vice-versa.

Literature Cited

Burton, G. J. 1953. Some techniques for mounting mosquito eggs, larvae, pupae and adults on slides. Mosquito News 13(1):7–15.

Burton, G. J. 1954. Rapid permanent mounts of mosquito larvae with creosote-alcohol, phenol-alcohol, lactophenol and polyvinyl alcohol. Mosquito News 14(2): 72–75.

[1] Entomologist, Sanitarian (R), FOA Mission to Liberia, Monrovia, Liberia.

FURTHER STUDIES ON THE CHEMICAL CONTROL OF RICE FIELD MOSQUITOES IN MISSISSIPPI[1, 2]

WILLIS MATHIS, CHRISTOPHER ELMORE, AND H. F. SCHOOF

INTRODUCTION. Preliminary investigations (Mathis, *et al.*, 1953) indicated that a preflood application of dieldrin emulsion at a rate of 1.0 pound of dieldrin per acre to rice fields in Mississippi gave excellent control of *Psorophora* larvae for an entire season. A similar treatment at a dosage rate of 0.5 pound of dieldrin per acre was highly effective during a 7-week period of observation. As these studies were confined to plots of 100 acres or less, an appraisal of the effect of the treatment upon adult mosquito populations was not feasible. In 1954 a large-scale test involving 2900 acres of rice in Bolivar County, Mississippi, was established to determine if satisfactory abatement of the adult population could be accomplished by this method of chemical control.

METHODS. The experimental area was selected to provide a heavy concentration of rice fields in the center zone with the latter being sufficiently removed from peripheral untreated rice acreages to minimize the infiltration of adults from the untreated fields. The treated rice fields approximated 2900 acres, of which 2700 acres were located within 6 miles of the center of the experimental area. This center point was 8 miles from any untreated rice fields, a distance which was considered beyond the general dispersion range of *Psorophora confinnis* (Quarterman, *et al.*, 1955; Horsfall, 1942).

All treated rice fields received a preflood application of dieldrin emulsion at a rate of 0.5 pound of dieldrin per acre. Treatment was made with a PT-17 airplane equipped with Venturi-type nozzles. Spray operations began on April 27 and extended through June 21, but the major part of the acreage (2100 acres) was treated before May 8. Some fields were flooded partially at the time of treatment, whereas with others 1 to 5 weeks elapsed before inundation.

An index to the larval population of *Psorophora* was obtained by the use of a cone sampler which covered an area of 0.5 square foot. Only fields which had been flooded recently were sampled. When early instar larvae were detected in a field, sampling was continued for several days to determine the number of larvae that reached maturity.

Appraisal of the adult mosquito populations was accomplished by the use of New Jersey light traps. Forty traps were operated twice each week during the experimental period. For proper distribution of the traps, the experimental area was divided into five zones in relation to the distance from the center of the treated area (figure 1). The code designations and distances involved were as follows: A Zone—0 to 2.9 miles, B Zone—3 to 5.9 miles, C Zone—6 to 8.9 miles, D Zone—9 miles, X Zone—greater than 9 miles.

The approximate location of the individual traps is given in figure 1. At farmhouses near the treated fields, one trap was located per each 200 acres of treated rice. The traps placed in outer zones (B, C, D,) also were operated at farmhouses, but the sites were selected to reflect any marked migration of mosquitoes into the treated zones from the untreated areas. In the X Zone the traps were located at houses near untreated rice fields.

RESULTS. Routine sampling of rice fields treated prior to June 1 failed to reveal any *Psorophora* larvae until 4 weeks following treatment. During this same period, *Psorophora* larvae were present in recently flooded untreated ditches and abandoned fields. However, by the sixth

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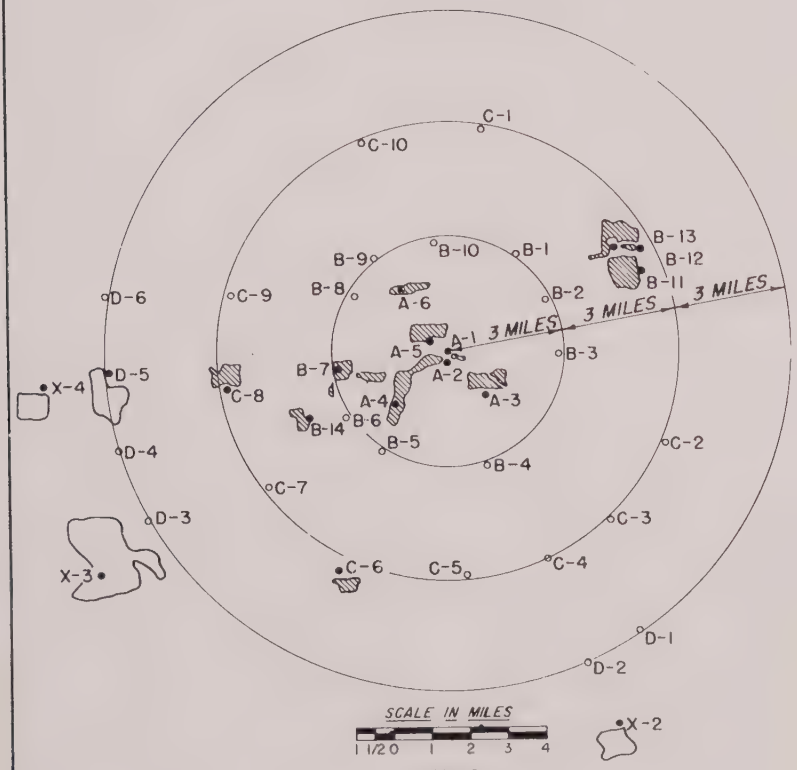
[2] Grateful acknowledgement is expressed to the Mississippi State Board of Health for its interest and its financial contribution to these studies.

FIGURE 1

90-T-40

DISTRIBUTION OF LIGHT TRAPS IN EXPERIMENTAL AREA



and seventh posttreatment week mature *Psorophora* larvae were numerous in reflooded fields. Two fields treated on June 14 and 21 and flooded within 10 days contained numerous larvae which were able to complete their development. In general, it appeared that fields which were flooded or reflooded later in the season showed the greatest initial larval population and also the maximum number of larvae surviving the treatment.

Adult population trends of *Psorophora confinnis* and *P. discolor* as measured by light trap collections are given in table 1.

TABLE 1.—The numbers of adult *Psorophora confinnis* and *P. discolor* collected in light traps within Zone A of treated area and the numbers collected in the untreated area (Zone X)

Week	*Psorophora confinnis*		*Psorophora discolor*	
	Ratio A to X	Average No. specimens per trap in X	Ratio A to X	Average No. specimens per trap in X
May 17	1–45	81	1–3	51
24	1–37	205	1–3	469
31	1–41	742	1–1	222
June 7	1–49	885	1–3	349
14	1–85	761	1–2	206
21	1–20	7,328	1–1	1,996
28	1–18	15,356	1–2	3,148
July 5	1–5	20,954	2–1	1,312
12	1–2	3,984	2–1	377
19	3–1	6,346	3–1	1,058
26	1–2	4,489	1–1	561
Aug. 2	1–5	4,301	1–6	1,303
9	1–4	440	1–3	35
16	1–4	583	1–14	337
23	1–2	1,081	1–1	28
30	1–2	302	3–1	10
Sept. 6	4–1	431	1–1	9

Excellent control of *P. confinnis* was apparent through the week of June 28. After that period the treatment was not considered effective.

In contrast to the excellent short-term abatement of *P. confinnis*, satisfactory control of *Psorophora discolor* never was obtained. In 8 of the 17 weeks, the average number of *P. discolor* per collection in the treated area was equal to, or greater than, that in the untreated area. Likewise, *Anopheles quadrimaculatus* was not under control at any time. While neither *P. discolor* nor *A. quadrimaculatus* is a serious daytime pest in the area, both are annoying nighttime biters.

As indicated by the average number of adult mosquitoes collected in the untreated zone in table 1, peak indices of *P. confinnis* prevailed during the 2-week period from June 28 through July 11. As in previous years, the population levels dropped markedly after the first week in August with subsequent densities being of a relatively low order. *P. discolor* reached maximum densities in late June but never displayed prevalences approaching those of *P. confinnis*.

Table 2 gives the percentages of the various species collected in the light traps in the different zones from May 17 to September 6. The predominant species collected was *Psorophora confinnis*, ranging from 52 to 84 percent. The highest percentage was noted in the *X* zone, the lowest in the *B* zone. *P. discolor* was the second most numerous species collected, ranging from 14 (*X* zone) to 44 (*B* zone) percent. In view of its scarcity in 1952–53, the relatively high incidence of *P. discolor* in the 1954 collections is puzzling. *Anopheles quadrimaculatus* constituted less than 4 percent of the specimens taken in any zone and all other species combined made up less than 1 percent of the total mosquitoes recovered. The two species of *Psorophora* represented 96 to 98 percent of the total specimens collected. The percentage of each species in the *X* zone undoubtedly was more representative of the true ratio of the mosquito populations near rice fields.

Although many of the earlier treatments were made under adverse weather conditions, this was not a reason for the failure of the treatment, since fields treated under ideal weather conditions also pro-

Table 2.—Percentages and numbers of indicated species of mosquitoes collected in light traps by zones from May 17 to September 6, 1954, Cleveland, Mississippi

	Zone A	Zone B	Zone C	Zone D	Zone X
Total number of mosquitoes	348,796	331,123	237,372	183,292	503,468
Psorophora confinnis	66.4	51.9	69.0	71.8	83.8
Psorophora discolor	29.4	44.3	28.3	25.3	13.6
Anopheles quadrimaculatus	3.7	3.4	2.1	2.4	1.6
Other spp.	0.5	0.4	0.6	0.5	1.0

duced unsatisfactory results. Moreover, the poor results obtained 10 days after treatment of fields gave no grounds for assuming that the extended periods between the initial and second flooding were the cause of failure.

To determine if a higher dosage of dieldrin per acre would have attained effective results, a series of small plots (15′×25′) were treated during July with dieldrin emulsion at the rates of 0.5, 1, and 2 pounds of dieldrin per acre as a preflood treatment. When these plots were flooded less than 1 week later, unsatisfactory control was apparent. In addition, three plots were flooded and the dieldrin emulsion applied as a postflood treatment at the rate of 0.1 pound per acre. The larval mortality varied but the average kill was less than 50 percent 24 hours after treatment.

During July, bentonite pellets containing 5 percent dieldrin were hand broadcast to an 0.75-acre plot in a field which had previously been treated with dieldrin emulsion at the rate of 0.5 pound of dieldrin per acre. The pellets were applied at the rate of 2 pounds per acre (0.1 pound of dieldrin per acre). Larval counts made 24 and 48 hours after flooding indicated an 87 percent reduction but this was not considered satisfactory since an average of 85 *Psorophora* larvae per square foot existed on the 48-hour check.

A 50-acre field previously treated with dieldrin emulsion also received a treatment of dieldrin impregnated bentonite pellets at the rate of 0.2 pound of dieldrin per acre. In the heavy population of larvae present, a 78-percent reduction in density was obtained 48 hours after treatment. Again the treatment was unsatisfactory since the last inspection revealed an average of 36 larvae per square foot. These poor results could be ascribed in part to the coverage of the field obtained by the airplane treatment.

The failure of fresh residues of dieldrin to kill *Psorophora* larvae indicated the possible occurrence of resistance in *Psorophora* populations. To evaluate this premise, *P. confinnis* pupae were collected in August from fields treated with dieldrin and from fields and flooded pastures which had not been treated. The adults obtained were held from 1.5 to 3 days and then exposed to dieldrin- or DDT-treated paper, using a method similar to that of Fay, *et al.* (1953). Sheets of mimeograph paper were dipped either in a 0.25 percent dieldrin-xylene solution, a 1 percent dieldrin-xylene solution, or in a 1 percent DDT-xylene solution and then removed, the excess solution being allowed to drain off. Following this, the sheets were placed on a rack until dry.

Twenty female *P. confinnis* adults then were placed in cardboard cylinders lined with the treated paper for 45 minutes, removed to untreated cages, offered food and water, and held for a 24-hour mortality count. With each series of tests a set of untreated controls were run.

The results showed that the mortality of females from dieldrin-treated fields ranged from 6 to 52 percent when exposed to paper treated with 0.25-percent dieldrin solution (Table 3). The average adjusted 24-hour mortality for these females was 17 percent. With adults from untreated fields the range in mortality was from 67 to 100 percent. There was a difference of 70 percent between the adjusted av-

erage 24-hour mortalities of the females from treated and from untreated fields. When the strength of the dipping solution of dieldrin was increased to 1 percent, the mortality ranged from 10 to 44 percent with an adjusted mortality of 22 percent.

TABLE 3.—Average 24-hour percent mortalities of *Psorophora confinnis* females from dieldrin treated and untreated rice fields, when exposed to dieldrin or DDT residues obtained by immersion of paper in xylene-toxicant solutions of several strengths as indicated

Treatment of paper	Total no. females	No. replicates	Adjusted 24-hour mortality percentages*
Females from Treated Fields			
Dieldrin—0.25%	603	33	17
DDT—1.0%	451	24	83
Check—	488	25	8
Dieldrin—1.0%	989	50	22
Check—	517	25	3
Females from Untreated Fields			
Dieldrin—0.25%	711	37	87
DDT—1.0%	628	32	66
Check—	519	26	17**

* Percentages derived by Abbott's formula.

** Possibly due to accidental insecticidal contamination of holding cages.

With DDT-treated paper, the range in mortality was from 62 to 100 percent with specimens from treated fields and from 26 to 100 percent with those from untreated fields. The adjusted mortality for mosquitoes from the treated fields was 83 percent and 66 percent for those from the untreated fields. This low mortality of the females from the untreated fields was due to the results obtained with specimens from one particular site. The average mortality from this location was 64 percent as compared to 83 percent from the other three locations.

DISCUSSION. The principal finding from these experiments is the demonstration of resistance to dieldrin residues in adult *P. confinnis*. Under the circumstances, it is difficult to ascribe this resistance to the 1954 dieldrin treatment of rice fields alone. Since the resident population of *P. confinnis* had been exposed to chemicals commonly employed for crop dusting (including endrin, aldrin, and dieldrin), it is assumed that this species was predisposed to a loss in susceptibility to dieldrin. Thus the complete treatment of all rice fields within a 6 mile radius by subjecting the population to intensive selection pressure caused a marked rise in its level of resistance to dieldrin. That such did not occur in fields treated in 1952 and 1953 is considered to be the result of the small and noncontiguous areas treated, a factor which permitted any resistance element of the *Psorophora* population to be diluted by the less resistant and dominant portion of the population.

The adult population indices in 1954 again support the previous assumption that only a small brood of mosquitoes is produced by overwintering eggs. They likewise implicate the cultural watering practices for rice growing as the major factor responsible for the copious *Psorophora* populations from June through early August.

As a further increment to the difficulty of the control problem, irrigation practices in Bolivar County are now being extended to pastures and to crops other than rice. With this enlargement of potential mosquito breeding area, control measures for *Psorophora* likewise require not only extension but adaptation to use under these conditions.

SUMMARY. Preflood airplane treatment of 2900 acres of rice fields in Bolivar County, Mississippi, in 1954, with dieldrin emulsion applied at a rate of 0.5 pound of dieldrin per acre failed to provide effective control of *Psorophora* breeding despite successful results with the same treatment in 1953. Plot tests showed dosages up to 2.0 pounds of dieldrin per acre to be ineffective against *Psorophora* breeding. Resistance studies with adult female *P. confinnis* demonstrated that in the treated area this species had acquired a marked resistance to dieldrin residues.

Literature Cited

Fay, R. W., Kilpatrick, J. W., Crowell, R. L., and Quarterman, K. D. 1953. A Method for Field Detection of Adult-Mosquito Resistance to DDT Residues. Bull. World Health Organization 9:345–351.

Horsfall, W. R. 1942. Biology and Control of Mosquitoes in the Rice Area. Ark. Agri. Expt. Sta. Bull. No. 427.

Mathis, Willis, Pickett, Vincent B., and Miller, W. O. 1954. Chemical Control of Rice Field Mosquitoes in Mississippi. Public Health Repts. 69(9):803–807.

Quarterman, K. D., Jensen, Jens, Mathis, Willis, and Smith, W. W. 1955. Flight Dispersal of Rice Field Mosquitoes in Arkansas. J. Econ. Entomol. (In press.)

CULICOIDES OF NEW ENGLAND (DIPTERA: HELEIDAE)

EDWARD I. COHER, WILLIS W. WIRTH[1] AND HERBERT KNUTSON[2]

The *Culicoides* have been the subject of an excellent study recently published by Foote and Pratt (1954). However, the present authors have additional material, much of which was collected during a two-year survey for the Communicable Disease Center, U. S. Public Health Service. This material is of interest particularly from the standpoint of increasing knowledge of the distribution of the group throughout New England. In addition, other material has been incorporated and verified, particularly that of the C. W. Johnson collection at Boston University which was not examined by Foote and Pratt nor included in their report. Previous records of all species, with complete data if the specimens have been examined, are also given. Notes on the biology of some of the species are included.

Most of the identifications have been made by or verified by the second author. Acknowledgements are due Frank R. Lisciotto and John C. Kuschke for their part in the collection of data. An asterisk indicates a new record for the state. Initials given in the collection records refer to: (EIC)—E. I. Coher, collector; (CWJ)—C. W. Johnson, collector; (HK)—H. Knutson, collector; (JCK)—J. C. Kuschke, collector; (FRL)—F. R. Lisciotto, collector; (MFS)—Maine Forest Service collection; (F & P)—in Foote and Pratt, 1954, see references; (OAJ)—in Johannsen, 1952, see references.

Culicoides biguttatus (Coquillet). ***Maine:** Ashland, VII-29-51(MFS); Dennistown, VII-21(JCK), VII-22, VII-25-51 (MFS); Greenville, VIII-1-51(MFS); Moosehorn, VII-3, VII-4, VII-6-51(MFS); Oxbow, VII-29-51(MFS); Square Lake, VII-8, VII-26-51(MFS); Vasselboro, VII-15-52(JCK). Extreme dates: VII-3 to VIII-1. **Vermont:** Laurel Lake, (F & P); Middlebury, VII-12(CWJ). **Massachusetts:** Amherst, (F & P); VI-19, VII-3, VIII-2, VIII-8 to 10, IX-10-51(EIC), light trap; Merrimacport, VI-11 to 16, VI-24, VI-25, VI-29, VI-30-54(EIC), hundreds in light trap except for final date; Sunderland, VII-12-51(EIC), light trap; Westhampton, VI-28-51(EIC), biting at 8:30 p.m.; Wilmington, (F & P). Extreme dates: VI-11 to IX-10. **Connecticut:** East Haddam, (OAJ); New Haven, VI-6-04(B.H. Walden); South Norwalk, V-30-43(M.E. Smith).

Culicoides canithorax Hoffman. **Maine:** Narrows, Mt. Desert, VIII-13-30(CWJ); South Harpswell, (F & P). **Massachusetts:** Cataumet, (F & P); Cranberry Bog, East Sandwich, VII-9-39(R.L. Armstrong); Mystic, East Sandwich, VI-22-39 (R.L. Armstrong); Essex Co.,(CWJ); Groton, (F & P); Hyannisport, VII-4-04; Woods Hole, VII-23-03(CWJ). ***Rhode Island:** Peacedale, VI-28-52(HK), biting.

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Culicoides crepuscularis Malloch. ***Maine:** Augusta, VIII-23-51(JCK); Moosehorn, VII-4-51(MFS); Oxbow, VIII-3-51(MFS). **Vermont:** Laurel Lake, (F & P). **Massachusetts:** Amherst, VII-6, VII-22, VII-27 to 29, VIII-8 to 10-51 (EIC), light trap; Boston, VII-9-20(CWJ); Martha's Vineyard, VIII-3-30(F.M. Jones); Merrimacport, VI-30-54(EIC), light trap; North Shore, VII(B.I. Gerry); Sunderland, VII-12, VIII-23-51(EIC), light trap. Extreme dates: VI-30 to VIII-23.

Culicoides furens (Poey). **Massachusetts:** Cataumet, (F & P); Martha's Vineyard, VIII-3-30(F.M. Jones). ***Rhode Island:** Peacedale, VI-28-52(HK), biting.

Culicoides guttipennis (Coquillet). **Vermont:** Laurel Lake, (F & P). ***Massachusetts:** Boxford, V-3-53(T.H.G. Aitken), reared from tree-hole; Scituate (Greenbush)—V-25-54(EIC), larvae taken in a tree-hole, pupated V-27 and subsequently, first adults emerged V-29 and V-30, all males. Larvae burrow head first in bottom organic material, work around, emerge partially, head first, and undulate like *Tubifex*. Pupae swim normally but also crawl along leaf and bottom surfaces, posterior first, in a hitching type of crawling; remain ordinarily quiescent at surface of water or on bottom, occasionally undulating on bottom; when disturbed sink directly to bottom without any apparent movement. Teneral adults darken in about one hour. Larvae found associated with *Aedes triseriatus* larvae and larvae of a dascylloid type. **Connecticut:** East Haddam, (OAJ).

Culicoides haematopotus Malloch. ***Maine:** Moosehorn, VII-4-51(MFS).

Culicoides hollensis (Melander & Brues). **Massachusetts:** Woods Hole, (F & P); Foote and Pratt express some doubt as to the status of this species.

Culicoides melleus (Coquillet). **Massachusetts:** Cataumet, VII-4 to 12-37(M. Foster); Fall River, (F & P). ***Rhode Island:** Kingston, VIII-7, VIII-30-52(HK), hundred in light trap; Peacedale, VI-28-52 (HK), biting.

Culicoides obsoletus (Meigen). **Maine:** Ashland, VII-19, VII-28-49(MFS), light trap; Aziscoos Lake, VII-8-10(C.A. Frost); Dennistown, VII-17 to 23, VII-28, VII-29-51(MFS), light trap, extremely abundant on VII-19; Dennysville, VII-14-51(MFS), light trap; Moosehead Lake, (CWJ); Great Pond, Mt. Desert, VII-16-18(CWJ); Southwest Harbor, Mt. Desert, VI-20 (CWJ); Oquossoc, VII-7, VII-8, VII-15 to 17, VII-19, VII-22, VII-24, VII-27-51 (MFS), light trap; Grand Lake Stream, Oxbow, VI-13-52(T.W. Kerr); Rangeley Lake, (CWJ); Square Lake, VII-7, VII-9, VII-10, VII-12-51(MFS), light trap; Greenville, Kellyland, Moosehorn, no data. Extreme dates: VI-13 to VII-29. **New Hampshire:** Old Spec Mt., Hwy. 26, Bear River, VI-4-52(HK); Bethlehem, VI-5-47 (J.B. Kindler); Bretton Woods, VI-24-13 (CWJ); Dixville Notch, VI-25(FRL), VII-10-52(EIC), found only along stream in woods and not in woods on VI-25; Dolly Copp Camp, White Mtns., VI-25-52(EIC-FRL), abundant, biting along Culhane Brook; 1st Connecticut Lake, VI-9, VI-11, VII-9-52(EIC), biting, abundant on VI-11; Franconia, (F & P); Glen House, VI-15-16 (CWJ); Jaffrey, VI-4-20(CWJ); Pike, (HK); 3rd Connecticut Lake, VI-24(EIC-FRL), VII-9, VIII-13-52(EIC), biting, abundant on VI-24; Warren, V-30-52 (HK); West Milan, first two weeks in July, (HK), abundant at base of mountains. Extreme dates: V-30 to VIII-13. **Vermont:** Downer St. For., VI-16(EIC-FRL), VI-25, VI-30, VII-21-52(EIC), extremely abundant, biting along shaded stream VI-16 to VI-25; Groton St. Pk., VII-1-52(EIC); Laurel Lake, (F & P); Maidstone St. Pk., VI-26-52(EIC), abundant; Moscow, VI-15, VI-17, VII-1-52 (EIC), abundant biting along stream; Mt. Holly, VI-13-52(EIC); North Troy, VI-12-52(EIC); Pittsfield-Sherbourne, VI-26-52(EIC); South Troy, VI-12-52(EIC); Starksboro, VI-4-52(EIC); Warren, VII-17-52(EIC). Extreme dates: VI-1 to VII-21. **Massachusetts:** Amherst, VIII-16, IX-4, X-12-51(EIC), light trap; Arlington, V-27-20(CWJ); Berkshire "area," (CWJ); Brookline, X-12(CWJ); Cape Cod "area," (CWJ); Chester, V-26-12(CWJ); Goshen,

VII-13-51(EIC), abundant, many complaints in vicinity; Merrimacport, VI-11 to 16, VI-25, VI-29, VI-30-54(EIC), light trap; Montague, VI-18-51(EIC), biting; North Adams, VIII-20 to 21-51(J. Gelheiser and EIC), light trap; North Shore, late June, July, early August(B.I. Gerry); Sherborn, X-30-26(C.A. Frost), biting; Sturbridge, (F & P); Westhampton, VI-28-51(EIC), biting at 8:30 p.m. Extreme dates: VI-11 to 16, to X-30.

Culicoides piliferus Root & Hoffman. ***Maine:*** Three Mile Pond, VII-17-52 (JCK). **Vermont:** Laurel Lake, (F & P). ***Massachusetts:*** Amherst, VII-6, VII-14, VII-27 to 29-51(EIC), light trap; Merrimacport, VI-11 to 16-54(EIC), light trap.

Culicoides spinosus Root & Hoffman. ***Massachusetts:*** Merrimacport, VI-25, VI-30-54(EIC), light trap.

Culicoides stellifer (Coquillet). **Massachusetts:** Amherst, VIII-30 to 31-54 (EIC), light trap; Merrimacport, VI-30-54 (EIC), light trap. **Connecticut:** East Haddam, (OAJ).

Culicoides travisi Vargas. ***Massachusetts:*** Merrimacport, VI-11 to 16, VI-25-54(EIC), light trap.

Culicoides variipennis (Coquillet). **New Hampshire:** Franconia, (CWJ), this specimen has not been found for examination by the authors. **Massachusetts:** Cascade, North Adams, (CWJ), a specimen so labelled has been found to be *venustus*. It seems probable that the New Hampshire specimen is *venustus* since that species and *variipennis* are quite dissimilar and it is doubtful that Johnson would miss such differences. This species then, cannot be considered to be confirmed in New England. However, a specimen from Quebec is in the collection of the Museum of Comparative Zoology (Harvard University) and undoubtedly the species must occur in New England.

Culicoides venustus Hoffman. **Vermont:** Laurel Lake, (F & P). ***Massachusetts:*** Merrimacport, VI-30-54(EIC), light trap; Cascade, North Adams, VI-14-06(CWJ), erroneously reported as *variipennis* in Johnson's list (1925). **Connecticut:** East Haddam, (OAJ).

Culicoides villosipennis Root & Hoffman. ***Maine:*** Sebago Lake St. Pk., (JCK). ***Massachusetts:** Amherst, VII-25-51(EIC), light trap; V-28-43(M.E. Smith), ex pupa, the larvae were taken in water in a tree-hole of a white oak; Martha's Vineyard, VIII-20-31(CWJ).

Culicoides n. spp. **Maine:** Moosehorn, VII-5-51, light trap, 1 large plain-winged female. **Massachusetts:** Amherst, VII-19, VII-22-51(EIC), light trap, females only, a plain-winged species.

Summary. Seventeen species of *Culicoides* are now reported from New England (*variipennis* is not included in these figures). The status of one species, *hollensis,* is in doubt. Sixteen of the species, including two new species known only from female specimens, were taken during this study. Not including the new species, 15 new state records are reported, 7 for Massachusetts, 5 for Maine, and 3 for Rhode Island. Massachusetts now has 15 species reported (including one new species), Maine 8 (including one new species), Vermont 6, Connecticut 4, Rhode Island 3 and New Hampshire has only a single species recorded. It is evident that much light trap collecting should be done in all states except Massachusetts in order to bring their lists up to significant levels. *Culicoides obsoletus* is apparently the most abundant and serious pest of the entire group, although along the coastal areas, the brackish water species are the cause for much complaint.

References

Foote, Richard and Pratt, Harry D. 1954. The *Culicoides* of the eastern United States. Publ. Hlth. Mon. No. 181:1–53+iv, Pls. 1–11.

Gerry, Bertram I. 1950. Salt marsh fly control as an adjunct to mosquito control in Massachusetts. Proc. N. J. Mosq. Exterm. Assoc. 1950:189–193.

Johannsen, Oskar A. 1952. Guide to the insects of Connecticut. Part VI. The Diptera or true flies. Fifth fascicle: Family Heleidae (Ceratopogonidae). Conn. State Geol. and Nat. Hist. Surv. Bull. No. 80:149–169, figs. 1–71.

Johnson, Charles W. 1925. Fauna of New England. 15. List of the Diptera or two-winged flies. Boston Soc. Nat. Hist. Occas. Papers 7:1–326.

MAYFLY CONTROL

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Mayflies are a common phenomenon in many sections of Florida and occasionally certain lake species may become seriously annoying to both lake-side residents and business establishments as a result of their periodic emergence in vast swarms.

Berner (1950) published an excellent treatise on the identification, distribution, ecology, and habits of the *Ephemeroptera* of Florida. However, little consideration has apparently been given to control of these insects, with the possible exception of very temporary control by adulticiding techniques.

Mayfly immatures are aquatic and undergo a hemimetabolous development involving a large number of preadult molts. The nymphal mouth-parts are well developed for chewing and oxygen is obtained directly from the water by means of abdominal gills. These insects are unique in that molting occurs after functional wings have been attained.

During the summer of 1953, a serious mayfly problem emanating from Bear Gully Lake near Goldenrod, Florida (Seminole County) was brought to the attention of the authors as a result of a petition to the Governor of the State from residents on this lake.

Reports received indicated that tremendous swarms of mayflies were emerging at approximately weekly intervals during the summer months, and some residents of this area declared that unless effective relief from these pests was forthcoming, serious consideration would be given to selling of their homes and moving away from these obnoxious pests.

Specimens collected were subsequently identified by Dr. Lewis Berner as *Hexagenia munda orlando,* which are endemic to the Central Highlands of Florida and confined to lakes of this area.

Results of sampling Bear Gully Lake on January 20, 1954, by means of an Ekman dredge, indicated a population of approximately 125,452,800 nymphs in this lake, which comprises about 200 acres.

It was decided to treat the lake with a suspension (wettable powder) of benzene hexachloride at a dosage of 0.24 lb. of gamma isomer per acre. Dispersal of the insecticide was accomplished on April 13, 1954 by gravity flow from a drum mounted in a small boat which was propelled by an outboard motor. The formulation flow was controlled by means of a valve and discharged through a rubber hose into the turbulent wake of the boat, while traveling in a pattern conducive to maximum distribution of the toxicant.

Post-treatment sampling twenty-three days following treatment of the lake failed to reveal the presence of any living mayfly nymphs. Periodic contact with residents of this area revealed that not a single adult mayfly was observed during the year of 1954 and from all indications complete control of these pests was obtained. Further, no apparent damage to fish or other aquatic wildlife resulted from chemical treatment of the lake.

Literature Cited

BERNER, LEWIS. 1950. The Mayflies of Florida. Univ. of Florida Press, Gainesville, Florida.

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NOTES ON THE BIOLOGY AND SEASONAL ABUNDANCE OF THE LARVAL STAGES OF *CULEX TARSALIS* COQUILLETT IN IRRIGATED AREAS OF SCOTTS BLUFF COUNTY, NEBRASKA (DIPTERA: CULICIDAE)

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Introduction. *Culex tarsalis* Coquillett appears to be the most important mosquito species concerned in the epidemiology of the virus encephalitides in western United States. It is also one of the most common species found in the irrigated areas of this region. In order to understand more clearly the relationship between irrigation and *C. tarsalis* production, studies were initiated during the 1953 season on the larval ecology of this species at Mitchell, Scotts Bluff County, Nebr. These studies were primarily concerned with evaluating the relative importance of the various habitats in which *C. tarsalis* larvae were found. In addition, observations were made on its seasonal occurrence, relative abundance, rates of development, and larval associations.

Because of its vector role in the transmission of encephalitis, *C. tarsalis* has been the subject of intensive studies in recent years. Jenkins (1950) has summarized much of this information and points out that there are still many important gaps in our knowledge of the biology of this species. The present work was undertaken to supply information on the biology of the immature stages in the field.

Methods. Forty-seven aquatic habitats, all that could be found within a 1-mile radius of Mitchell, Nebr., were studied. These habitats, classified on the basis of gross ecological characteristics, included representative types of all aquatic situations occurring in Scotts Bluff County and were typical of extensive areas of the North Platte Valley. Stations were established for each habitat and routine inspections were made once each week. Larval populations were sampled by dipping each station thoroughly with a pint-size white enamel dipper. The number of dips taken depended on the size of the station. At each inspection, water areas and mosquito breeding areas were estimated; also the source of the water was determined. This information along with the average number of larvae or pupae per dip was recorded.

In order to compare the mosquito productiveness of the various habitats a "Production Index" was used. The Production Index is based upon the larval density in relation to the amount of breeding area; and equals the average number of the fourth-instar larvae and pupae per dip, times the number of square feet in the breeding area.

For studies on larval growth rates, individual egg rafts of *C. tarsalis* were isolated in rearing containers in permanent seepage areas. The containers were galvanized iron cylinders, 20 inches in diameter and 12 inches deep. They were screened on top to prevent contamination with additional ova after the initial isolation of a single egg raft. The lower end was buried in the bottom mud along the shallow margins of permanent seepage areas (Fig. 1). Observations of each isolation were made daily and the date of hatching, date fourth instar was reached, date of pupation, and date of adult emergence were recorded.

Results. In the study area there was a total production index value of 20.9 million for all species of mosquitoes. Of

[1] This work was done while the author was Senior Assistant Scientist, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education and Welfare, Logan, Utah.

FIG. 1. Rearing containers used in isolating egg rafts of *Culex tarsalis* for studies on larval growth rates under field conditions.

this total 12.1 million or 58 percent were for *C. tarsalis*. The production of this species in the various habitats was approximately as follows: permanent or semipermanent seepage areas, 9.8 million; temporary surface pools, 2.3 million; roadside borrow pits and weed clogged ditches, only 0.001 million.

A total of 18,684 fourth-instar larvae and pupae of *C. tarsalis* was collected from various habitats. This species was found most commonly in association with *Culiseta inornata*, and occasionally with *Culex restuans, Culex pipiens, Culex salinarius, Culex territans, Anopheles walkeri,* and *Uranotaenia sapphirina* in permanent or semipermanent water areas. It was also found associated with *Aedes dorsalis, Aedes vexans,* and *Aedes nigromaculis* in temporary water areas.

First-instar *C. tarsalis* larvae were collected from a permanent seep near Mitchell, Nebr., on May 7, and the first fourth-instar from the same seep on May 25. A gradual increase in *C. tarsalis* larval populations took place in all types of habitats during June, and a seasonal peak in production occurred during the week ending July 11 (Fig. 2). Large numbers of larvae continued to develop until the middle of August, after which a gradual decline in larval populations took place. The last fourth-instar larvae and pupae were collected on October 29. These results are similar to those obtained in studies made in Utah where Rees (1943) found that the larvae of *C. tarsalis* usually appeared first in late May and that they were frequently found until early November.

The egg rafts of *C. tarsalis,* collected in the field, were found to contain from 143 to 331 eggs, and averaged 244. Brennan and Harwood (1953) in laboratory studies found an average of 230 eggs per raft; while Brookman (1950) found that in California egg rafts most frequently contained between 100 and 149 eggs. The rafts were common during June, July, and August resting on the water of larval

habitats. In the field, egg rafts from which larvae had emerged were separated at sight from unhatched ones by the fuzzy appearance given them by the open hatching caps.

Hatching generally occurred 1 to 3 days after the egg raft was isolated. The number of days required to complete development in permanent seeps at different dates varied throughout the season, temperatures being an important influence. The period from hatching to adult emergence in permanent seepage areas ranged from 14 days at average air temperatures of 78.5° F. to 31 days at 63.4° F. Husbands and Rosay (1953) found that in irrigated pastures in California *C. tarsalis* could complete development in 9 to 10 days following irrigation. Individual rafts included eggs of both sexes. This was demonstrated by rearing of both sexes from isolated rafts. Several generations

Figure 2

WEEKLY PRODUCTION INDEXES OF *CULEX TARSALIS* ACCORDING TO TYPE OF BREEDING PLACE
MITCHELL, NEBRASKA, 1953

NOTE PRODUCTION INDEX = (AVG NO FOURTH-INSTAR LARVAE AND PUPAE PER DIP) X (ESTIMATED BREEDING AREA IN SQ FT)

are capable of developing in a single season in Scotts Bluff County.

Most of the larval habitats in which *C. tarsalis* was found were man-made. The greatest production of this species occurred in seepage areas associated with irrigation. Beds of *Chara,* an aquatic plant, were frequently present in places where high production of *C. tarsalis* occurred. In Scotts Bluff County this observation was made so frequently that *Chara* might be considered as an indicator of high *C. tarsalis* production in permanent and semipermanent seeps. Large numbers of larvae also developed in temporary surface pools in irrigated pastures and hay meadows.

DISCUSSION. Because of its abundance and the frequency with which it attacks humans, *C. tarsalis* may be considered a pestiferous species in the North Platte Valley (Anon., 1953). Knowledge of its bionomics is important from the standpoint of pest mosquito control as well as possible encephalitis transmission. In this region extensive seepage areas form early in the summer soon after irrigation begins. These seeps permit continual development of *C. tarsalis* throughout the season. Extensive salt grass pastures and hay meadows are irrigated 3 or 4 times during the summer. Because of irregular topography, the fields are irrigated by wild flooding and when enough water is applied to cover the high spots, excessive ponding occurs in the low places. Water often stands in the depressions for several weeks, thereby permitting *C. tarsalis* to complete its aquatic stage.

Prevention and control of *C. tarsalis* in the North Platte Valley must take into account both the seepage areas and the irrigated pastures. Because of the extensiveness of these habitats, temporary control by means of chemicals would be difficult and costly. Emphasis should be given to permanent corrective work directed toward elimination of man-made habitats associated with irrigation. Measures to prevent seepage from canals and laterals should be utilized where needed and drains should be provided for the removal of surface water.

SUMMARY. 1. From May through October (1953), larvae and pupae of *Culex tarsalis* occurring in various habitats in Scotts Bluff County, Nebr., were studied. The breeding habitats which produced the greatest numbers of larvae were permanent or semipermanent seepage areas and surface pools.

2. The greater portion of *C. tarsalis* breeding habitats in Scotts Bluff County were found to be man-made and related directly to irrigation. Permanent control of *C. tarsalis* in the area studied will involve the elimination of seepage areas and residual pools on irrigated pastures.

3. In these studies the first fourth-instar larvae appeared on May 25. A seasonal peak in larval population occurred during the week ending July 11. The last fourth-instar larvae and pupae were collected on October 29.

4. In permanent or semipermanent seepage areas *C. tarsalis* was found in association most commonly with *Culiseta inornata,* and in temporary water areas with *Aedes dorsalis, A. vexans,* and *A. nigromaculis.*

5. *C. tarsalis* egg rafts were found to contain from 143 to 331 eggs, average 244. Hatching generally occurred in 1 to 3 days, and the period from hatching to adult emergence ranged from 14 to 31 days.

Literature Cited

ANON. 1953. Summary of investigations July–Sept. 1953. Technology Branch, U. S. Dept. of Health, Education and Welfare, Public Health Service, C.D.C., Atlanta, Georgia.

BRENNAN, J. M. and HARWOOD, R. F. 1953. A preliminary report on the laboratory colonization of the mosquito, *Culex tarsalis* Coquillett. *Mos. News* 13(2):153–157.

BROOKMAN, B. 1950. The bionomics of *Culex tarsalis* Coquillett in irrigated areas of a lower sonoran environment. Thesis (unpublished) Univ. of California.

HUSBANDS, R. C. and ROSAY, B. 1953. Irrigated pasture mosquito ecology studies—1952. Calif. Mosq. Control Assoc. 20th Ann. Conf. Proc. and Papers, pp. 33–37.

JENKINS, D. W. 1950. Bionomics of *Culex tarsalis* in relation to western equine encephalomyelitis. Amer. Jour. Trop. Med., 30(6):909–916.

REES, D. M. 1943. The mosquitoes of Utah. Univ. of Utah Bull. 33(7):1–99.

THE DISCOVERY OF A MEMBER OF THE *ANOPHELES MACULIPENNIS* COMPLEX BREEDING IN TREEHOLES IN FRANCE

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Introduction. Since the discovery by Falleroni in 1926 (Falleroni, 1926) that *Anopheles maculipennis* Meigen, an important vector of malaria in the Old World, could be separated into different races or varieties on the basis of differences in the eggs, a large amount of research has been performed on this species. Hackett, Martini, and Missiroli (1932) discovered that the races of the species differ greatly in their ability to transmit malaria, and that their feeding and breeding habits are quite diversified. Russell, Rozeboom, and Stone (1943) recognize seven varieties in the complex which occur in the European Region. These are *A. sacharovi* Favr, *A. melanoon melanoon* Hackett, *A. melanoon subalpinus* Hackett and Lewis, *A. labranchiae atroparvus* van Thiel, *A. labranchiae labranchiae* Falleroni, *A. maculipennis maculipennis* Meigen, and *A. messeae* Falleroni. A variety of breeding places have been reported for each of these "species" with each one usually having a definite preference. For example, *maculipennis maculipennis* larvae usually occur in fresh water in hilly sections, whereas *labranchiae atroparvus* larvae are usually found in brackish water along coastal areas, (Russell, *et al.*, 1943). As far as can be determined no previous investigator has reported any member of this complex in Europe breeding in tree holes.

The Present Study. On 1 July 1954, members of the Survey Section of the 485th Medical Company (Preventive Medicine) (Separate) made a routine collection of mosquito larvae from a tree hole about 15 miles east of La Rochelle, Charente-Maritime, France. These specimens were brought to the laboratory, and at that time it was noticed that a number of fourth instar *Anopheles* larvae were present in the collection. These were removed and mounted, and all were identified as *Anopheles plumbeus* Stephens, with the exception of one specimen which was identified by the writer as *A. maculipennis*. The following day the tree hole was visited again, and all the water from the hole was removed with the aid of a suction pump. Ten more *plumbeus* and two more *maculipennis* were taken on this occasion. All the specimens were fourth instar at the time of the collection. The two *maculipennis* larvae were placed in a finger bowl containing water taken from the tree hole and placed under a bell jar in an effort to secure adults. One of these larvae died on 4 July 1954, and it was removed and mounted. The other specimen continued its development in a normal manner. It pupated on 9 July 1954 and emerged as an adult female on 13 July 1954. An effort was made to rear this adult in the hope of securing ova in order that an exact determination could be made. The specimen died, however, on 14 July 1954. It was mounted and determined by the writer to be a member of the *maculipennis* complex. On subsequent visits to the tree hole no more specimens of either species were found. As no ova were obtained from the original specimens, it was impossible to determine which member of the *maculipennis* complex had been collected.

The tree from which the specimens were taken was *Platanus acerifolia* Willd., a species quite common in this section of France. The hydrogen ion concentration of the water in the tree hole was determined to be 7.2. An associated species, present in large numbers with *Anopheles maculipennis* and *A. plumbeus*, was the common European tree hole breeder, *Aedes geniculatus* Oliv.

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Ten additional fourth instar specimens of *A. maculipennis* were collected from another tree hole on 31 October 1954, near the city of Rochefort, also in the Department of Charente-Maritime. These specimens were all mature at the time of collection. Five were mounted as larvae, and five were allowed to continue development. Two of these five eventually emerged as adult females on 9 November 1954 and were readily identified as *A. maculipennis*. These specimens died soon after emerging as adults. The tree from which these specimens were taken was *Fraxinus angustifolia* Vahl. The hydrogen ion concentration of the water in the cavity was 7.2, as in the original collection. Associated species were *A. plumbeus* and *Aedes geniculatus*, as in the original collection.

Of the ten larvae collected on this occasion, one was unique in that it possessed two well developed antennal hairs. These hairs were of equal size and inserted quite close to each other on the basal fourth of the antenna.

SUMMARY. Thirteen specimens of *Anopheles maculipennis* were collected from rot cavities in the trees *Platanus acerifolia* Willd., and *Fraxinus angustifolia* Vahl, in the Department of Charente-Maritime, France, near the cities of La Rochelle and Rochefort by members of the 485th Preventive Medicine Company. As far as can be determined, this is the first instance of this species of mosquito having been found breeding in a tree hole. Three larvae were reared to maturity and emerged as adult females which were readily identified as members of the *maculipennis* complex. As no eggs were secured, it was impossible to determine the variety of the specimens collected. One of the larvae was noticed to possess two well developed antennal hairs.

ACKNOWLEDGEMENTS. The writer is indebted to Dr. Paul Jovet of the French Museum of Natural History in Paris for determining the species of trees. He also is indebted to SFC Earl G. Wilcox and Sgt. William W. Zack of the 485th Preventive Medicine Company for their assistance.

Literature Cited

FALLERONI, D. 1926. Fauna anofelica italiana e sue habitat (paludi risaie, canali). Riv. di Malariol. 5:553–93.

HACKETT, L. W., MARTINI, E., and MISSIROLI, A. 1932. The Races of *A. maculipennis*. Amer. Jour. Hyg. 16:137–62.

RUSSELL, PAUL F., ROZEBOOM, LLOYD E., and STONE, ALAN. 1943. Keys to Anopheline Mosquitoes of the World, Publ. by Amer. Ent. Soc., Lancaster Press, Lancaster, Penna. 152 pp.

THE OVIPOSITION OF *HAEMAGOGUS EQUINUS* IN NATURE (DIPTERA, CULICIDAE)

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So far as the writer is aware, there are no recorded observations on the egg-laying of any species of *Haemagogus* mosquitoes in nature. In June 1945, the writer was fortunate enough to observe the process of oviposition of *Haemagogus equinus* Theobald. During a collecting trip to the Plant Introduction Gardens at Summit, Canal Zone, in search of *Haemagogus* larvae, many were collected from tree holes, bamboo stubs, and crevices between the buttressed roots of *Ficus* trees. Upon approaching a tree hole which, on previous visits, had contained *Haemagogus* larvae, a female *Haemagogus* was seen flying back and forth over it, in full sunlight. The hole was in the main trunk of a small mango tree, approximately five feet from ground-level; it was about 4 inches in diameter and about 3½ inches deep, and contained about three-quarters of an inch of dark brown water, over a substratum of dead leaves and other detritus. The rounded edge of the hole was covered with very short green moss, kept moist by capillarity from the water beneath.

The female mosquito flew back and forth over the hole for some minutes, then alighted and crawled about on the thin mossy cover. Within a few moments the first egg was laid. Normally, when in a resting position, the terminal segments of the abdomen are turned upward. The female turned the end of the abdomen downward before thrusting into the moss, prior to extruding an egg. No preliminary probing movements of the abdomen were noted. After six eggs were deposited, none very close to each other, and at intervals of approximately one minute each, the female was captured in a dry glass vial. The pieces of mossy bark on which the eggs had been laid were carefully removed with a knife, placed in a stoppered glass shell-vial, and taken to the laboratory.

Three of the eggs, attached to the mossy bark, were then placed in water from a bamboo section in which other *Haemagogus* larvae had been growing. The remaining three eggs, attached to the moss, were kept for a little more than 72 hours in a humid atmosphere in a shell-vial, and were then immersed in water from the bamboo section. The first three eggs did not hatch, indicating that a period of maturation may be required before hatching takes place. The second lot of three eggs hatched, and the larvae, fed on brewers' yeast, produced one male and two female adults. These were found to be *Haemagogus equinus* by examination of the terminalia of the single male.

The captured female was transferred to a shell-vial covered with bobbinet, and provided with a piece of moistened corrugated paper, in the hope that additional eggs might be deposited. The vial was kept at room temperature, 80° to 85° F. No more eggs were laid, and the mosquito died a few hours more than two days after it was captured. It was dissected, and two apparently mature ova and a number of immature ova were found in its ovaries. Possibly it had been injured during transportation from the field to the laboratory, or probably some tactile or other stimulus necessary for oviposition was absent in the artificial conditions of the laboratory. The female had toothed tarsal claws, and the characteristic white knee-spots of *H. equinus,* which are absent from the other species of *Haemagogus*

[1] Laboratory of Tropical Diseases.

known from the Canal Zone and Panama.

The foregoing account differs somewhat from that given by Bates (1949) of the experimental oviposition behavior of *Haemagogus spegazzinii falco* Kumm *et al.,* which he called *H. spegazzinii.* Bates states that the female was placed in a glass vial, with "a filter-paper disc in the bottom, moistened with distilled water. The mosquito was observed making exploratory movements over the disc with the tip of the abdomen, but no eggs were deposited. A slip of filter-paper was inserted into the vial until it touched the wet disc in the bottom, and then appressed to the side of the vial, making a moisture gradient. The mosquito crawled onto this, continuing the exploratory movements of the abdomen. Finally one egg was laid, at about the point on the filter paper where the moisture ceased to be visible. Then seven more eggs were laid in about five minutes. Between each egg the female explored the paper carefully with the tip of the abdomen, and usually laid another egg when she chanced to touch a previous egg—in other words, responding to irregularities in the surface . . . the tip of the abdomen was placed in close contact with the surface of the paper and drawn steadily forward (the mosquito remaining motionless except for the abdominal movement), leaving the egg adhering to the paper."

The female *H. equinus* seen ovipositing by the writer could not be observed as closely as Bates watched his *H. spegazzinii falco* female, for fear of distracting it and causing it to fly away. But apparently it made no preliminary probing movements with the tip of the abdomen, but placed its eggs at random on the moss surrounding the tree hole, at some distance from the water-line below.

Bates also quotes Wesenberg-Lund (1921, p. 75) as describing the oviposition of *Aedes communis* (de Geer), but from his account it is evident that Wesenberg-Lund did not actually observe the process, as did Bates and the writer, but only found the eggs where they had been deposited by the females.

References

BATES, M. 1949. The Natural History of Mosquitoes. The Macmillan Co., New York. (p. 93).

WESENBERG-LUND, C. 1921. Contribution to the Biology of the Danish Culicidae. Mem. Acad. Roy. Sci. et Lettres, Copenhagen, Sec. Sci., 8th Ser., 7, No. 1, 210 pp.

AN INVASION OF THE GULF COAST BY SALT-MARSH MOSQUITOES

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During September, 1954 the Gulf Coast area of Texas and Louisiana was subjected to a severe invasion of the salt-marsh mosquitoes, *Aedes sollicitans* and *Aedes taeniorhynchus.* The factors that contributed to the enormous swarms that invaded the Gulf Coast communities are of interest.

During the months of June, July and August, 1954, the rainfall in Jefferson County, Texas, totaled 8.41 inches, about three inches of which fell during the last four days of August. The average rainfall of the area for this period is 16.71 inches. As a result of the reduced precipitation the coastal marshes became completely dry. The brackish marshes that extend inland as much as 30 to 40 miles also became dry. Drought conditions also prevailed in the watersheds of the Sabine and Neches rivers, further contributing to the drying of the inland marshes.

During the summer there were no high tides that reached a point that would flood the marshes. By the end of August, even

the ditches in the marshes were dry. Minnows and other natural predators of mosquito larvae were completely absent.

It had been necessary, early in the summer, to construct a temporary dam across the Neches River north of Beaumont to prevent salt water from entering the fresh water supply for the county. The dam was located about 47 miles, via the river, from the Gulf of Mexico.

In late August and early September there were rains which provided some water. High tides and high water also occurred, the tides reaching a mark of 4.1 feet above mean level. At about this time a tropical disturbance moved inshore around Brownsville. It is possible some of the tides were influenced by that storm especially since the off-shore areas of the Gulf of Mexico are very shallow and tides are considerably affected by wind velocity and direction. (As an example of the topography of this area, the Mosquito Control office is 19 miles from the nearest point on the Gulf. The elevation here is 15 feet above mean sea level. The river marshes around Beaumont are below the five foot contour.)

The water remained high for several days, allowing time for it to back up into all the low-lying areas. Observations made from the District's airplane showed vast reaches of flooded marshlands.

On the evening of September 9 swarms of mosquitoes moved into Port Arthur. On September 11 and 12 they rolled across the mid-county area and on September 13 Beaumont was invaded. The entire city of Beaumont was not covered completely until the 14th or 15th of September.

The slow flooding of the marsh areas provided for what might be termed a continuous production of salt-marsh mosquitoes. Emergence of adults occurred for at least a week, and possibly for ten days. During the prolonged emergence period, the winds in the area averaged 10 to 15 miles per hour greater than normal. There was, also, a constant changing of wind direction. Communities that were surrounded by breeding areas were invaded from the north, south, east and west on successive days. Each invasion added to the numbers already established in the community.

The combination of factors created conditions that made control measures in Jefferson County ineffective as far as the general public was concerned. As the following figures show, our operations were inadequate to provide relief, regardless of how efficient they may have been.

Surrounding our cities are at least 450,000 acres or 19,602,000,000 square feet of marshes capable of producing *Aedes sollicitans* and *A. taeniorhynchus*. Assuming an average of 10 adults emerging from each square foot, there would be 196,020,000,000 mosquitoes surrounding our populated areas. Field observations indicated that our spraying by airplane resulted in at least 99 percent kill. However, a 99 percent kill would still leave 1,960,200,000 mosquitoes to annoy a population of 250,000. Or, 7,840 mosquitoes per person!

There seems to be no one factor that caused such a massive flight. Every indication points to general conditions that were most unfavorable to the natural enemies of the mosquitoes, and favorable for the mosquitoes themselves.

The Eyes of Texas are upon you. Turn the page.

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FEB. 5th-8th, 1956

TWELFTH ANNUAL MEETING

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THORACIC VESICLES IN *ANOPHELES* LARVAE

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Public Health Service
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While studying the larval morphology and physiology of *Anopheles quadrimaculatus* Say (Diptera, Culicidae),[2] the writer has repeatedly observed some conspicuous thoracic vesicular structures which have apparently never been described. This paper gives a description of them based on a detailed study of more than 65 intact living larvae, representatives from each instar being used. Specimens were examined in distilled water at 120 to 1500 X either in micro slides, or in a special chamber (Jones, 1953a), or held between slide and coverslip.

The vesicles exist as huge, elliptical, grape-like clusters of numerous, clear, colorless, turgid, fluid-filled spheres within the dorso-lateral portion of the thorax (figure 1, v.) They lie in the hemocoel, dorsal and lateral to the alimentary canal, above and partly around the salivary glands; and, in the fourth instar, they abut the imaginal discs. They appear to be connected *only* to the body wall epidermis. The largest vesicles are much larger than any of the cells in the entire body. They are definite structures and are not to be confused with circular holes in the fat body or with special configurations of superficial tracheae. They bear no resemblance to other organs in the thorax.

Under high magnifications (900 to 1500 X) the vesicles appear to lack nuclei. Each vesicle is formed by a very thin structureless envelope (<0.5 μ thick) which resembles the connective tissue membranes surrounding the fat bodies. Vesicles are interconnected very much like a mass of soap bubbles. They vary greatly in size even within the same individual but appear to remain constant in size during a stadium. Fat droplets (<3 to 9 μ diameter) form around them. Sessile hemocytes also may be seen lying over or among the vesicles.

Thirty-one vesicles measured from 13 first instars ranged from 4.5 to 19.5 μ in diameter (mean size 12.0 ± 0.5 μ). Seventy-six vesicles from 15 second instars varied from 5.2 to 47.0 μ (mean size 20.7 ± 0.6 μ), and 102 vesicles from 15 third instars measured from 9.4 to 103.4 μ (mean size 46.1 ± 0.9 μ). Among 22 fourth instars 341 vesicles ranged from 11.8 to 164.5 μ (mean size 60.3 ± 0.5 μ).

In very young first-stage larvae vesicles cannot be clearly distinguished from the watery vacuoles in the fat body, but in somewhat older first instars they are readily separable from each other. The precise mode of their formation was not studied. In newly molted larvae of other stages numerous thoracic vesicles can be seen extending from the anterior edge of the prothorax down into the metathorax. As development proceeds, those in the prothorax are obscured by fat body. During the last quarter of the fourth stadium (age estimation by method given by Jones, 1953b), the vesicles are densely overgrown by fat body and obscured by the great development of the imaginal discs. In larvae which are about to pupate, vesicles either cannot be seen at all, or superficial ones are dimly seen only at the junction of the meso- and metathorax.

The fate of the thoracic vesicles is not known, but they are apparently absent from pupae. In larvae fixed with either 70 percent ethanol or with 10 percent aqueous formalin, the vesicles can be seen

[1] Laboratory of Tropical Diseases.

[2] Reared under laboratory conditions at National Institutes of Health since 1942.

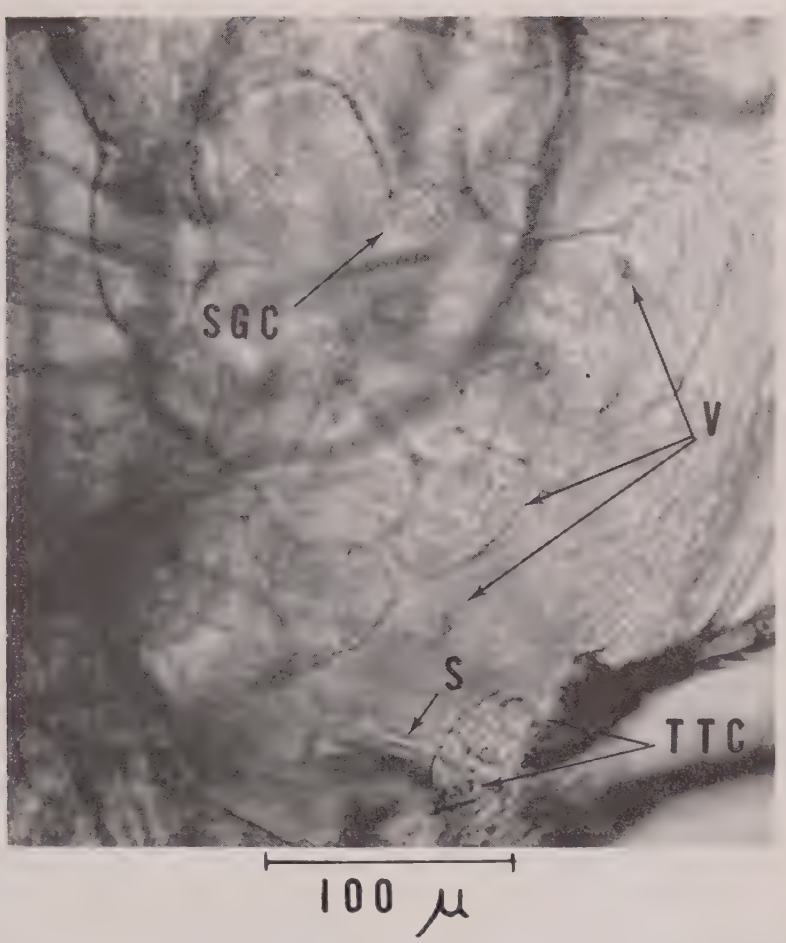

Fig. 1. Photomicrograph showing thoracic vesicles (v), underlying salivary gland cells (SGC), trichogentormogen cell complex (TTC), and scolopophorous sensillum (S).

externally only with difficulty; their finer details are wholly obscured. The vesicles are easily ruptured and not amenable to ordinary dissections. Sectioned material is equally unsatisfactory since the vesicles tend to collapse and do not show up when stained.

Although daily observations on the same individuals did not reveal any marked changes in general size or number of the vesicles in relation to age within stadia, the great variations in sizes of the vesicles, together with the fact that many vesicles become progressively obscured as development proceeds, makes it difficult to settle the question. Vesicles did not disappear in larvae starved several days.

Similar but less numerous and less conspicuous thoracic vesicles were also observed in *Culex tarsalis* and *C. pipiens*. Their vesicles were more superficial and peripheral than in *Anopheles*. Vesicles

were not observed in fourth instar *Aëdes aegypti*.

The relation of the vesicles to other tissues is obscure. It may be that they are a specialized kind of fat body. No clues were obtained concerning the function of thoracic vesicles.

It may be that Giles (1906) saw thoracic vesicles, for in his description of "the hepatic masses" he wrote, "The other two pairs are placed at a distance from the intestine, in the corners of the pro- and metathorax respectively." However, his illustration and description are so vague that it is difficult to be certain that he distinguished them from fat body, gastric caeca, or salivary glands. It is possible that vesicles have been overlooked for so long because they were mistaken for portions of the salivary glands.

References

GILES, G. M. 1906. A handbook of the gnats or mosquitoes. William Wood Co., N. Y., 530 pp.

JONES, J. C. 1953a. A chamber for observations on living larvae of anopheline mosquitoes. Science 117:42.

JONES, J. C. 1953b. Some biometrical constants for *Anopheles quadrimaculatus* Say larvae in relation to age within instar. Mosq. News 13(4): 243–247.

THE RESURRECTION OF *AEDES MELANIMON* DYAR[1]

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H. G. Dyar in 1924 (p. 126) described *Aedes melanimon* from 15 female and 2 male specimens taken at Bakersfield, California. He noted the similarity of this species to *dorsalis* as follows: ". . . I considered this as a variety of *dorsalis* until a male was obtained. The very distinct hypopygium shows that a distinct species is represented." Freeborn (1926) examined a series of males of this form supplied by C. K. Badger who had also supplied Dyar with his material. He (Freeborn) figured the male terminalia under the name of *Aedes dorsalis melanimon*. He appears to have been of the opinion that the terminalia of *dorsalis* could be produced by distortion of the terminalia of *melanimon* or *vice versa* (p. 372) but he also retained *melanimon* as a "race" of *dorsalis*. Later authors (Matheson, 1929, 1944; Freeborn and Bohart, 1951) have considered *melanimon* to be a subjective synonym of *dorsalis*.

In the process of examining large numbers of male terminalia of Minnesota *Aedes* the writer inadvertently dissected a Californian specimen of *"Aedes dorsalis"* which had terminalia quite different from those of Minnesota *dorsalis*. Subsequently two additional males were found that were identical with the first one. Two of these males are from Tulare, California (October 31, 1942) and the third from Porterville, California (October 26, 1942); all were collected by John T. Medler and pertain to the species *melanimon*.

The terminalia of *melanimon* and *dorsalis* are illustrated in the accompanying figures and are most easily separated by the nature of the claspette filament and the apical and basal lobes of the basistyle. In *melanimon* the apical lobe is quite large; this is particularly pronounced when the terminalia are examined while in potash or in water immediately after clearing in potash. When the specimens are dehydrated for mounting the apical lobe tends to bend back on itself so that it appears smaller; however, the difference

[1] Paper No. 3312 Scientific Journal Series Minnesota Agricultural Experiment Station, St Paul 1, Minnesota.

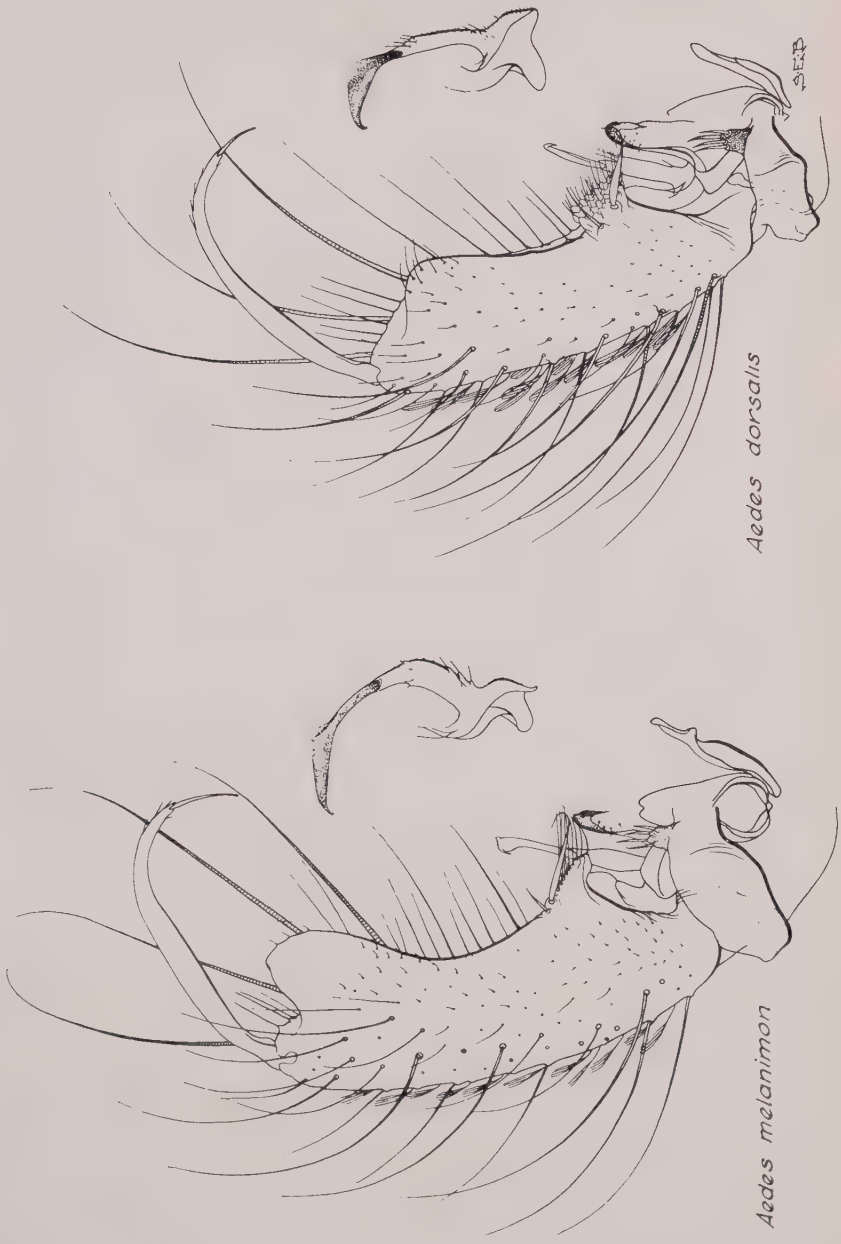

Fig. 1. Male terminalia of *Aedes dorsalis* and *A. melanimon*.

in size between the two species is still pronounced as can be clearly seen in the illustrations which were drawn from terminalia mounted in balsam.

The claspette filament of *melanimon* has a long shank which is very short in *dorsalis*. The posterior surface of the basal lobe of *melanimon* slopes gently to the basistyle and is not sharply curved as in *dorsalis*. The author has not been able to convert specimens of one species into those of the other by distortion although it appears likely that if the terminalia were sufficiently distorted, these differences would not be apparent and the two species could be confused.

Dyar stated that in *melanimon* "the wing-scales are all dark or at least unicolorous, there being no contrasting dark and light veins as in *dorsalis*." In the specimens at hand the wing scales are not unicolorous, there being a large number of pale scales at the bases of the wing veins although the outer portions of all veins are completely dark-scaled.

Aedes melanimon is now known from Bakersfield, Porterville, and Tulare. Yamaguti and LaCasse (1951, p. 70) figure the terminalia of *melanimon* under the name of *dorsalis* although the same authors (LaCasse and Yamaguti, 1950) had previously illustrated the terminalia of *dorsalis* (p. 134), presumably from Japanese specimens. The specimen of *melanimon* is said (p. 262) to be from Modesto, California. The illustration of the terminalia of *dorsalis* in Carpenter *et al.* (1946, p. 180) also pertains to *Aedes melanimon*.

Summary. The attention of culicidologists is directed to *Aedes melanimon*, a neglected species of mosquito occurring in California.

Acknowledgement. The author would like to express his gratitude to Sylvia Barr for the preparation of the illustrations.

References

CARPENTER, S. J., MIDDLEKAUFF, W. W., and CHAMBERLAIN, R. W. 1946. The mosquitoes of the southern United States east of Oklahoma and Texas. Amer. Midland Nat., Monog. No. 3, 292 pp.

DYAR, H. G. 1924. Two new mosquitoes from California. Insec. Insc. Menstr., 12:125–127.

FREEBORN, S. B. 1926. The mosquitoes of California. Univ. Calif. Publ., Tech. Bulls., Entom., 3:333–460.

FREEBORN, S. B. and BOHART, R. M. 1951. The mosquitoes of California. Bull. Calif. Ins. Surv., 1:25–78.

LACASSE, W. J. and YAMAGUTI, S. 1950. Mosquito fauna of Japan and Korea. U. S. Army, Office of the Surgeon, HQ 8th Army APO 343, pp. viii+268+2 appendices of 7 and 268 pp.

MATHESON, R. 1929. A handbook of the mosquitoes of North America. Baltimore: C. C. Thomas Publ., pp. vii+268.

MATHESON, R. 1944. *Ibid.*; second Edition. Ithaca, N. Y.: Comstock Publ. Co., pp. viii+314.

YAMAGUTI, S. and LACASSE, W. J. 1951. Mosquito fauna of North America. Part V. Genus *Aedes*. U. S. Army, Office of the Surgeon, HQ Japan Logistical Command APO 343, pp. iv+265.

In your 1956 Budget, be sure to include expenses for the AMCA Convention in Beaumont, Texas

A NOTE ON SWARMS OF SO-CALLED "WOODS" MOSQUITOES IN McKINLEY PARK, ALASKA

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"Woods" mosquitoes are supposed to breed in cool, shaded waters and their adult activities, including swarming, are said to take place in the forest. This concept does not always apply, however, because certain "woods" species abound north of the trees in the Arctic and above timber line in mountains. Martini (Natvig, 1948), noted in the far north a change of preferred larval breeding places of these species to open, unshaded pools, and called this switch of habitat, *geographischen Brutplatzwechsel.* For example, *Aedes communis* (DeG.) and *impiger* (Wlk.) are recognized American temperate zone "woods" species (Matheson, 1944; Rempel, 1953), but they also occur in virtually treeless Arctic parts of Alaska and Canada. Knight (1951), who leavens his taxonomic studies with ecology, has described "tundra" varieties of *Aedes punctor* (Kby.) and *hexodontus* Dyar. A stupendous, diffuse swarm of presumably tundra *A. punctor* and *communis* over the Hudson Bay Railway tracks near Churchill, reported by Hocking *et al.* (1950) for a single evening, is the only recent reference found to Arctic swarms. Swarming of *impiger* apparently has not been reported, but the typical swarms of *communis,* first described by Wesenberg-Lund (1920–21) from Denmark, are now well known from North America. *Communis* males swarm in the deep shade of secluded alcoves of the forest. In this paper a change of swarming site to the open, which is comparable to the change of larval habitat reported by Martini, is noted for *A. communis* of alpine Alaska. The swarms of *communis* and *impiger* to be described were observed near timber line in Mount McKinley National Park, Alaska. About 70 percent of the Park is said to be above timber line which ranges 2500–3000 feet elevation.

Methods, Areas, Swarming Sites. Approximately five acres of jumbled sand-gravel-boulder wash dotted with barren pools, scrubby willows, stands of fireweed and purple vetch located conveniently near camp were selected for a swarm study area. Two evenings of reconnaissance in mid-June had uncovered large swarms of *Rhamphomyia,* a dance fly, and one mosquito swarm in the dissected triangle where Riley Creek receives Hines Creek and enters the Nenana valley at about 1700 feet elevation. The swarming site of the mosquito, which proved to be *A. communis,* was an exposed area above two huge half-buried boulders, one white, one grey. The boulders lie in a flood channel in a dry section interposed between long, barren pools teeming, however, with *Aedes pullatus* larvae. The pools were favored flight lanes of male mosquitoes approaching or leaving the swarming site. On ten evenings during the period June 16–July 9, small swarms of *communis* were observed here. Three swarms of *impiger* were found at three different locations outside the swarm study area.

Swarming behavior was studied by direct observation. Samples of the swarmers were collected periodically for later identification from genitalia mounts, inspection for orchid pollinia, and experiments. On each evening when the swarming site was visited, whether a swarm occurred or not, minimal weather records of temperature, wind, cloudiness, and rain for that evening and the preceding 24-hour period were made. The most representative "swarming" temparature seemed to be taken at 20:30 (Alaska Standard Time) near the ground.

Acknowledgment is due Superintendent Grant Pearson of the National Park Service for many favors, to Gertrude Frohne for identification of orchid pollinia, and

to Dick and Jim Frohne for construction of a log bridge over Hines Creek to the swarm site.

SWARMS. *Aedes communis* (DeG). Swarms of this species were observed at the Riley Creek site over the two boulders on the evenings of June 16, 17, 18, 19, 23, 25, 28, July 2, 7, 9. Swarming ordinarily started between 19:15 and 19:45 and was terminated between 20:15 and 20:45 when the deep valley became almost dark. The air was calm on swarming nights. Either there was no wind or an intermittent breeze of less than 4 mph. Seven evenings, the exceptions being June 17, 18, 19, were clear following rain. No swarm appeared at the site June 14, 15, 20, 21, 22, 24, 26, 27, 30, July 1, 4, 5. Seven of these twelve negative evenings were rainy, one was smoky from a distant forest fire, and two were very windy. The remaining negative evenings, July 4 and 5, came near the close of swarming there. The latter day was, nevertheless, an exceptional one for anticipated swarming did not occur despite clearing after rain. Temperatures seemed to play no great role. The ground-level air temperature at 20:30 ranged 49–60 F. on swarming evenings and 48–62 F. on the stated non-swarming ones.

The measure of the swarm used—average count or estimate of males at the core—was little to begin with and less and less for successive swarms. On the first four evenings the figure ranged from 10–50 males. By July it was 5–10, and for the last two swarms, only 2–5 and 1–3. Swarming behavior is characteristic so that a single male at a known swarming site may constitute a recognizable swarm, a point made by Nielsen and Greve (1950). It is thought likely there were larger swarms before observations began June 16, especially since the peak emergence of *communis* adults occurred about May 21 and it is assumed that mating was largely completed long before the middle of June. No instance of mating at any mosquito swarm was observed in this study.

Swarming male mosquitoes were invariably interfered with by aggressive male dance flies of *Rhamphomyia* sp., usually outnumbering the mosquitoes and swarming diffusely around them or where the mosquitoes were wont to swarm (negative nights) for a radius of 10–15 feet. Pursuit and grappling were frequent but only two instances of actual capture of *Aedes* males were seen at this site.

Individual mosquito males probably remained a very few minutes at the core as a rule. Sometimes at intervals of low count at the core one was seen merely to tarry there for less than half a minute as if in passing. They flew away on a beeline to the northeast or southwest, the directions of the pools between which the swarm site was located. Swarming was commonly below eye level and the observer had to sit to see swarmers well. It is reasonable to suppose most of the males were resting most of the time. The only proven resting place, however, was flowers of the orchid, *Habenaria obtusata* (Pursh) where some of them acquired tell-tale pollinia on their eyes. One evening in three successful instances among many failures at following a male mosquito's flight away from the swarm, each mosquito turned about and reentered the core *without* resting. As usual the swarm (core) was reconstituted within a few minutes after annihilation with the insect net; numerous recruits were obviously resting or flying close by. Captured males on release did not return (directly) to the swarm.

Aedes impiger (Wlk.) Two unstable swarms of *impiger* males were seen on a bright afternoon, 16:30–1700, June 24, near Sanctuary River at elevation 3100 feet approximately. The moving cores consisted of about 50 males each. They became diffuse and recondensed again at intervals in a manner suggestive of *A. excrucians* swarms. Both swarms averaged about five feet above the water of different intermittent pools teeming with *A. pullatus* larvae and pupae. A third evidently induced swarm of *impiger* took place at dusk August 7 in camp near Riley Creek over a bright-yellow gasoline drum. Unique

observations of swarms, i.e., those which are not repeated several nights, are of uncertain normalcy and specificity. This is especially true of large recently hatched mosquito populations; such *new* mosquitoes are sometimes easily induced to swarm, as over the observer, his net, etc. For whatever unique swarming observations may be worth these of *impiger* were probably composed of *old* males. All three swarms were in the open without apparent reference to vegetation.

Discussion. If swarming is courtship, why then was no mating seen? The explanation may be: Mosquitoes mate a few days after emergence. For many species male swarms provide the female a "releaser" stimulus. The bulk of mating for a one-brooded species occurs within a week following peak emergence. The swarms of this study occurred several weeks to two months later.

Shortly after peak emergence the swarms are very large and frenzied—*the period of early (mating) swarms.* The longevity of males may exceed six weeks. With proper stimuli males swarm throughout adult life. The period of early (mating) swarms is followed by a much longer *period of late (nonfuntional) swarms.* It is reasonable to assume that the late swarms are equally if not more characteristic of the species than the early ones.

Current data are adequate for description of the typical swarms of very few mosquitoes, but it is likely that when details are well known, prominent among the specific differences will be the type of swarming site chosen.

Summary. Ten small swarms of *Aedes communis* (DeG.) and three of *A. impiger* (Wlk.) were observed near timber line in Mount McKinley National Park, Alaska. Swarming occurred in the open. (Most swarms of *A. communis* described in the literature have occurred in deep shade of the forest.) No mating was seen. Swarming of *A. communis* generally took place on calm, clear evenings following rain ending during the morning or afternoon.

Some of the male *A. communis* carried pollinia of the orchid *Habenaria obtusata* (Pursh).

Male *Rhamphomyia* sp. (Diptera: Empididae) swarmed about the swarms of *A. communis* and harried the mosquitoes.

References

Hocking, B., Richards, W. R., and Twinn, C. R. 1950. Observations on the bionomics of some northern mosquito species (Culicidae: Diptera). Can. J. Res., D, 28:58–80.

Knight, K. L. 1951. The *Aedes (Ochlerotatus) punctor* subgroup in North America. Ann. Ent. Soc. Am. 44:87–99.

Matheson, Robert. 1944. Handbook of the mosquitoes of North America. (p. 167, 170), 314 pp., Ithaca, N. Y.

Natvig, L. R. 1948. Contributions to the knowledge of the Danish and Fennoscandian mosquitoes. Culicini. (p. 58), Norsk Entomologisk Tidsskrift Suppl. I, 567 pp., Oslo.

Nielsen, E. T., and Greve, Hans. 1950. Studies on the swarming habits of mosquitoes and other Nematocera. Bull. Ent. Res. 41(2):227–258.

Rempel, J. G. 1953. The mosquitoes of Saskatchewan. Can. J. Zool. 31:433–509.

Wesenberg-Lund, C. 1920–21. Contributions to the biology of the Danish Culicidae. (p. 156). D. Kgl. Danske Vidensk. Selsk. Skrifter Natur. og Matematisk Afd. 8 Rackke VII, 1:210 pp.

Be in Beaumont, Texas, February 5–8, 1956 and get, firsthand, the latest information on mosquitoes and their control.

FEEDING ADULT MOSQUITOES ON PRESERVED BLOOD TO MAINTAIN EGG PRODUCTION[1]

J. A. KNIERIM, A. O. LEA, J. B. DIMOND, AND D. M. DELONG

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The laboratory mass-rearing of mosquitoes has become a matter of routine for a number of species, and providing a blood meal for the adult females is generally an indispensable part of maintaining egg production. Even before the beginning of this century, entomologists began feeding adult mosquitoes in various ways and on different substances. In general, the problem of feeding many adults simultaneously has been solved in one of three ways: (1) offering a live animal, e.g. chick, guinea pig, dog, rabbit, or human arm; (2) using a membrane, e.g. Baudruche membrane, or a prepared rat, chick, or bat skin stretched over a source of preserved blood; (3) absorbing preserved blood on a cotton pad. As far as egg production is concerned, the first method, using a live host, appears to be used almost exclusively in the regular laboratory mass-rearing of most species. The membrane technique has been used largely in special feeding experiments for parasite transmission studies (Bishop and Gilchrist, 1944), where egg production was not important, and in nutritional studies (Woke, 1937) and Greenberg (1951). However, in many cases it has not been easy to induce large numbers of mosquitoes to probe or take a meal through a membrane, and this technique has not been applied to general laboratory rearing. The third method, the use of a blood-soaked pad, has seldom been employed in mass-feeding mosquito colonies to maintain egg production, although there are a number of references to this technique in connection with parasite and virus transmission work. MacGregor and Lee (1929) found that *Aedes argenteus (-aegypti), Culex pipiens,* and *Anopheles maculipennis* would feed on citrated blood if honey was added. Russell (1931) in malarial transmission studies, induced *Culex fatigans, Aedes aegypti,* and *Anopheles ludlowi* to feed on blood spread on gauze. Knowlton and Rowe (1935) fed equine encephalomyelitis virus to several species of mosquitoes by soaking a cellucotton pad with a mixture of glycerine-brain emulsion and defibrinated horse blood. In these examples too, the production of eggs from these meals was not the primary aim.

Considering the number of reports of mosquitoes successfully fed from blood-soaked cotton pads, it is surprising that this method has not been reported in connection with routine mass-rearing in the laboratory of such a commonly cultured species as *Aedes aegypti.* Recently, Schiavi and Franco (1949) recommended feeding a mixture of defibrinated blood and honey on cotton to maintain colonies of *Anopheles albitarsis, Anopheles strodei,* and *Culex fatigans.* McLintock (1952) has used a blood-sucrose mixture on a cotton pad in the continuous rearing of *Culiseta inornata.*

It has been the standard practice in the entomology laboratory at The Ohio State University to keep several rabbits as host animals for the stock colonies of *Aedes aegypti* and *Anopheles quadrimaculatus* adults. It was difficult to keep the rabbits healthy because of the large number of mosquitoes which fed on them regularly. However, it was primarily the time required in their care and feeding, and the problem of putting a rabbit into a stock cage and taking it out, that prompted the search for a faster and simpler method of feeding the stock colony.

Since it was customary to provide all test and holding cages with a 10 per cent

[1] This work has been aided by a research grant from the National Institutes of Health, Department of Health, Education, and Welfare through The Ohio State University Research Foundation, Columbus 10, Ohio.

honey solution on a cotton pad as a source of food for the males and for the females between blood meals, it seemed likely that female mosquitoes would ingest enough of a blood-honey mixture from a cotton pad to lay viable eggs.

In the first experiments, using *A. aegypti,* a cotton pad soaked in citrated beef blood with 10 per cent honey added was placed on the floor of a test cage. The females engorged on the mixture and laid an abundant supply of eggs. A large colony of *A. aegypti* was then established, and egg production was maintained for over a year by feeding the adults only the citrated blood and honey mixture.

Several experiments indicated that hanging the blood-pad in the cage rather than placing it on the floor would give better results. Tests were also made to determine the importance of heat as a factor in feeding. Thus, it was found that a high rate of oviposition could be obtained from blood without the honey added if the blood-saturated pads were heated to 42°–45° C. before hanging them in the cage.

Most investigators agree that *A. aegypti* which have just ingested whole blood in the course of "biting" an animal or piercing a membrane always have the midgut full and the ventral diverticulum containing rarely more than a trace. When whole blood alone was fed from a pad, dissections showed that, by this method too, the midgut was distended with blood, only traces being found in the ventral diverticulum, whereas a blood-honey mixture was dispatched primarily to the ventral diverticulum. Therefore, the use of whole blood alone will result in more "natural" ingestion.

However, at the suggestion of Dr. C. R. Philip of the Rocky Mountain Laboratory, freshly citrated blood was frozen for storage purposes. Because of hemolysis during freezing, it appeared that the females did not feed as well on the hemolyzed blood alone, and therefore, it was necessary to add honey to the frozen blood in order to induce feeding and maintain egg production. Frozen blood plus 10 per cent honey has been used successfully for the past four months in our stock colony.

The results obtained with *Aedes* served as a basis for developing an artificial feeding method for *Anopheles quadrimaculatus.*

Preliminary experiments with *Anopheles* were with citrated beef blood and honey mixtures absorbed on cotton pads and hung in the cages. The response to the food was poor. The resulting eggs were not sufficiently abundant to be used in culturing the insects, and investigations were initiated to find a more satisfactory method of feeding blood.

Observations by many workers indicated that heat was a powerful attrahent to many species of mosquitoes, and in this laboratory it had been noted that *Anopheles* would swarm to warmed surfaces. Therefore, attempts were made to induce the mosquitoes to feed on blood heated to human body surface temperature (34–35° C.).

In preliminary trials, test tubes wrapped with blood-soaked cotton were inserted through a hole in the tops of small cages. The temperature was raised by placing hot water within the tubes. It was observed that the female *Anopheles* were strongly attracted to the heated blood, and it was not necessary to add honey to the blood. A large percentage engorged within a very short time, and egg production was found to be abundant.

In adapting the technique to the stock culture, a large Pyrex test tube (32×200 mm.) was fitted with a Masonite collar (2×3×⅛ inches) with a hole which would admit the bore of the test tube but not its lips (Fig. 1-A). This collar fitted into a frame in the top of the stock cage so that the tube was suspended within the cage. The tube was wrapped with blood-soaked cotton, and the temperature was maintained by circulating hot water from a tap or a reservoir, through the tube.

More recently, it has been found that an electric heating unit can conveniently replace circulating water. The heating units in use are either a 20 or 40 watt,

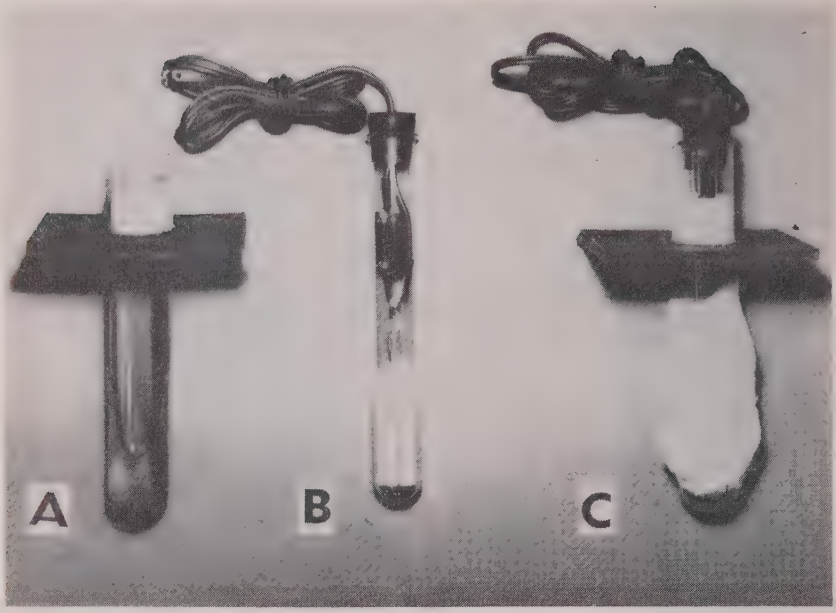

FIG. 1. A—A large Pyrex test tube (32×200 mm.) fitted with a Masonite collar. The tube contains the water necessary for operation of the heating unit. B—A 20 watt, single unit, thermostatically controlled aquarium heater. C—The heater in place within the large test tube which has been wrapped with cotton.

single unit, thermostatically controlled, electric aquarium heater (Fig. 1-B). These heaters consist of a thermoregulator and heating element contained in a 25×200 mm. Pyrex test tube, and are available at any aquarium supply store at very low cost.

The test tube containing the heating unit is placed in the larger tube around which is wrapped the blood-soaked cotton. Since the heaters will not function properly unless in a liquid medium, the space between the two tubes must be completely filled with water. The thermoregulator should be set to interrupt the current when the surface temperature of the blood pads reaches 35–38° C.

Several minutes are required for the temperature of the food to reach equilibrium after which the feeder may be allowed to run as long as insects are attracted. Feeding on alternate days appears to be satisfactory for maintaining a large supply of eggs from *Anopheles*.

Using the feeding method outlined above, the culture of *Anopheles* has been maintained in our laboratory for over nine months without the necessity of keeping mammalian hosts. Frozen blood has not been tested with this species.

With this method, it has been possible to feed the anophelines proteinaceous foods other than blood. Attempts have been made with skimmed milk, a 10 percent solution of egg albumin, and a 10 percent solution of proteose-peptone, and in all cases oviposition has resulted. The mosquitoes feed better on these foods if 1 part of honey is added to 9 parts of the protein solution.

These procedures for mass-feeding have numerous advantages over that of introducing a live animal into the stock cage. Blood is usually available at the local slaughterhouse and can be citrated and stored under refrigeration for at least two weeks or for several months if frozen. The blood-pad can be left in the cage

overnight, and few or no mosquitoes are lost in changing to a fresh feeder. These techniques also offer an excellent means of studying the nutritional requirements of the adult mosquito. The results of feeding milk to *A. aegypti* adults have been reported by Lea *et al.* (1955), and the preliminary results of feeding mixtures of amino acids by Dimond *et al.* (1955).

Literature Cited

Bishop, Ann, and Gilchrist, Barbara M. 1944. A method for collecting sporozoites of *Plasmodium gallinaceum* by feeding infected *Aedes aegypti* through animal membranes. Nature, London, 153:713–714.

Dimond, J. B., Lea, A. O., Brooks, R. F., and DeLong, D. M. 1955. A preliminary note on some nutritional requirements for reproduction in female *Aedes aegypti*. Ohio Jour. Sci. 55:209–211.

Greenberg, J. 1951. Some nutritional requirements of adult mosquitoes *(Aedes aegypti)* for oviposition. Jour. Nutrition, 43:27–35.

Knowlton, G. F., and Rowe, J. A. 1935. Handling mosquitoes on equine encephalomyelitis investigation. Jour. Econ. Ent., 28:824–829.

Lea, A. O., Knierim, J. A., Dimond, J. B., and DeLong, D. M. 1955. A preliminary note on egg production from milk-fed mosquitoes. Ohio Jour. Sci., 55(1):21–22.

MacGregor, M. E., and Lee, C. U. 1929. Preliminary note on the artificial feeding of mosquitoes. Tr. Roy. Soc. Trop. Med. and Hyg., 23:203–204.

McLintock, J. 1952. Continuous laboratory rearing of *Culiseta inornata* (Will.) (Diptera: Culicidae). *Mosquito News,* 12(3):195–201.

Russell, P. F. 1931. A method for feeding blood meals to mosquitoes—male and female. Amer. Jour. Trop. Med., 11:355–358.

Schiavi, P. A., and Franco, A. C. 1949. Nova tecnica para repasto sanguinco dos mosquitoes. Arq. de Hig. e Saude Pub., S. Paulo., 14(39/42): 57–59.

Woke, P. A. 1937. Effects of various blood fractions on egg production of *Aedes aegypti* Linn. Amer. J. Hyg., 25:372–380.

THE BREEDING OF *HAEMAGOGUS ARGYROMERIS* D. AND L. IN SALINE WATER (DIPTERA, CULICIDAE)

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Haemagogus argyromeris D. and L. 1921 is a widespread and common mosquito in the Panama Canal Zone and adjacent Panama. In its choice of breeding-places, it is perhaps less restricted than any other species of *Haemagogus*. Dyar (1) records the larvae from tree holes. Galindo *et al.* (2) record the larvae from "a greater variety of breeding habitats than any other *Haemagogus* in this area [Panama], including tree holes, cans, coconut hulls, tires, rock holes, terrestrial bromeliads and occasionally ground pools" (p. 118), and from "5-gallon cans which had been left on the slopes of the island" [Flamenco, near the Pacific entrance to the Panama Canal].

In 1949 the writer recorded *H. argyromeris* larvae from terrestrial bromeliads in the Panama Canal Zone and the Republic of Panama, and once from an arboreal bromeliad in El Valle de Anton, in Panama (3). He now reports the larvae of this species breeding in definitely saline water contained in rock holes on the Pacific shores of the Republic of Panama.

Punta Paitilla is a low, isolated, rocky

[1] Laboratory of Tropical Diseases.

promontory lying east of the city of Panama. The eastern shoreline of this promontory is composed of a volcanic breccia ("a rock composed of angular fragments cemented together"). The softer components have been worn away, leaving in their place pot-holes in the harder rock. These holes are well above the high-water line, even of the Pacific tides, which may reach 18 feet above mean sea level. During the dry season (January-April) these pot-holes are dry, but shortly after the rains begin they become filled with water. During the high "spring" tides a strong surf dashes against the rocks, and wind-driven spray is blown on-shore. Some of this salt spray reaches the pot-holes in the rocky cliff, and evaporates. After the onset of the rains in May, these pot-holes contain saline water of various concentrations. In some of them, late in June and July, and again in October, during several years, fourth-instar larvae of *Haemagogus* were collected. These were reared to adults in the laboratory, and found to be *H. argyromeris* by examination of the male terminalia. These larvae all had very short anal gills, an adaptation to the high salt content of the water.

Several samples of the water in which the larvae were found were analyzed for salt content by the chemist of the Board of Health Laboratory in Ancon, C. Z. These samples were reported to contain various amounts of sodium chloride (NaCl), up to 0.9 percent. The NaCl content of English Channel sea water is given by Sollman (4) as 2.7 percent.

It is well known that some species of Culicidae, e.g., *Aedes taeniorhynchus, A. sollicitans* and *Anopheles aquasalis,* will breed in undiluted or slightly diluted sea water, but a search of the literature shows that no species of *Haemagogus* (except *argyromeris,* as here reported) is known to tolerate sodium chloride. All species of the genus *Haemagogus* are "container breeders" (5), and are found in habitats such as tree holes, usually high in organic matter, but normally lacking in sodium chloride.

According to Galindo *et al.,* (2) *H. argyromeris* is "predominantly a ground level biter." Up to the time of writing (March 1955) no evidence, experimental or otherwise, is on record as to its capability to transmit yellow fever.

References

1. DYAR, H. G. 1928. The mosquitoes of the Americas. Carnegie Institution of Washington, Publ. 387, p. 138.

2. GALINDO, P., CARPENTER, S. J., and TRAPIDO, H. 1951. Ecological observations on forest mosquitoes of an endemic yellow fever area in Panama. Am. J. Trop. Med. 31:98–137.

3. KOMP, W. H. W. 1949. A note on disease-bearing mosquitoes breeding in bromeliads. *Mosquito News* 9:72.

4. SOLLMAN, T. 1948. A Manual of Pharmacology. W. B. Saunders Co. p. 732.

5. SHANNON, R. C. 1931. The environment and behavior of some Brazilian mosquitoes. Proc. Ent. Soc. Wash. 33:1–27.

Fifteen inches of rain on a weekend! What would you do? Learn how the eastern mosquito workers met this challenge. Be at Beaumont, Texas, February 5–8, 1956.

EDITORIAL

On September 21, 1953 Dr. Bickley wrote to the President of the American Mosquito Control Association, then Dr. F. C. Bishopp, accepting the post of Advertising Manager for *Mosquito News*. With characteristic directness he stated at the time that it would be for two years. And with characteristic firmness, as of this issue, September, 1955, exactly two years later, he relinquishes those duties, much to the regret of all of us who have been associated with him in the affairs of *Mosquito News* and the Association.

The costs of publishing and distributing *Mosquito News* constitute the largest item of expense for the AMCA. The treasurer's report for 1954 shows that 41 percent of the combined income from dues and advertising was from advertising. The importance of the advertising is even more apparent when we consider that advertising paid 60 percent of the cost of printing and distributing *Mosquito News*.

Advertising does not simply flow in spontaneously, as Chris Williamson, Bob Vannote, Harry Stage and Bill Bickley will testify. The first three persons mentioned built up a fine inheritance for Dr. Bickley, and if we have not recognized this editorially before, we do so now. Dr. Bickley maintained and enlarged this inheritance, and now passes it on to a worthy successor, Mr. Francis P. Creadon. To Dr. Bickley and his predecessors, all of whom worked tirelessly and unselfishly on this most important job, the Association owes much of its growth, and *Mosquito News* much of whatever success it has achieved as a medium for the dissemination of information on mosquitoes.

We take great pleasure in announcing that Mr. Francis P. Creadon, of Riverside, Illinois, has accepted the responsibility of advertising manager of *Mosquito News*. Mr. Creadon is a trustee of the DesPlaines Valley Mosquito Abatement District. He is an insurance executive, and his experience in this field, added to his interest in and knowledge of mosquito control constitute an exceptionally good background for an advertising manager of our publication. Professional mosquito workers will feel great satisfaction in the fact that talent from outside the profession is thus being enlisted in their cause, and they will welcome and support the new advertising manager with whole-hearted enthusiasm.

INVITATION TO MEMBERSHIP TO PRESENT PAPERS AT ANNUAL MEETING

Anyone desiring to present a paper relating to mosquitoes or their control, is requested to send to Fred H. Stutz, Program Committee Chairman, 905 Court House, Miami 32, Florida, before November 15, 1955, the following information:

Exact Title of Paper
Time Required for Presentation (15-minute limit)
Equipment Needed for Presentation
Name and Address of Author

It is hoped that *Mosquito News* can publish most of the papers presented, although the authors have the option of publishing elsewhere if they wish. Regardless of the length of the paper as presented, and irrespective of the number of lantern slides or other visual aids used in the presentation, for publication in *Mosquito News* the paper should be so written (modified from the paper as presented, if necessary) as to comprise not more than 6 printed pages and only essential illustrations, preferably not more than 2. Where more than 6 pages are necessary, the paper should be accompanied by a statement indicating that the additional pages will be paid for either by the author or by an agency with which he is connected.

NEWS AND NOTES

ROSCOE C. DAVIS IS JOINT AUTHOR OF AN ARTICLE IN THE CALIFORNIA VECTOR VIEWS FOR MAY, which discusses the interrelationships between pest control operators and sanitarians. He states that changes in the field of refuse disposal have been rapid during the past few years. As an example, mixed garbage and rubbish are no longer being dumped at hog feeding yards and sanitary land fills have recently been placed in operation in the cities of Livermore, Santa Cruz, San Rafael, Modesto and Clovis. As is well known, sanitary land fills are invaluable aids to mosquito control, not only by eliminating tin cans and similar items which hold water but by filling in swampy areas and thus making them unavailable for mosquito breeding. Those who have seen the potentialities for mosquito breeding which also exist in a poorly-run pig farm, will easily understand the importance of A.M.C.A. member Davis' activities in that area.

A CONFERENCE OF MILITARY ENTOMOLOGISTS WAS HELD FROM 9 THROUGH 13 MAY, IN WASHINGTON, D. C., which was attended by 84 persons, chiefly entomologists, but also including sanitary engineers and medical officers concerned with insect and rodent control. As might be expected, mosquito control was a large item on the agenda and it is interesting to note that 30 of the conferees were members of the American Mosquito Control Association.

CDR JOHN HIRST SENDS US NEWS OF THE SECOND MEETING OF THE MARE ISLAND MOSQUITO ABATEMENT COMMITTEE, which was held during May. The meeting was under the chairmanship of Captain D. W. Lyon, MC, USN, and was advised by Drs. Stanley F. Bailey and Robert M. Bohart, among other specialists in the mosquito control field. The Committee has been notably successful in its activities, according to the report.

DR. (MAJ.) GEORGE J. BURTON OF THE INTERNATIONAL HEALTH DIVISION, U.S.P.H.S., who has been stationed for the past two years in Liberia with F.O.A. (now I. C. A.—International Cooperation Administration), is moving to Katmandu, Nepal, where his address will be U.S.O.M. Sounds fabulous as Kubla Khan.

THE *Skeeter*, OFFICIAL ORGAN OF THE VIRGINIA MOSQUITO CONTROL ASSOCIATION, brings news in its June issue of increasing interest in mosquito control in that state. A substantial area, comprising 3,500 residents, has recently been added to the Kempsville District of Princess Anne County. A Citizens Committee has been formed in Great Bridge area, Norfolk County, to develop a plan based on a report by the State Health Department. Newport News has reactivated its Mosquito Control Commission to resume direction of the activities which have for several years been carried on by the Department of Public Works. And, large, new areas have recently been added to the control zones now being covered by the Virginia Beach-Princess Anne County Commission and the Western Branch District, westward from Portsmouth, comprising some 12,000 persons.

E. CHESTER ROBINSON, NEW MANAGER OF THE ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT, CALIFORNIA, reports that in June they were visited for four days by Mr. Raden Soekro Wirasendjaja, of the Ministry of Health, Djakarta, Indonesia, and A.M.C.A. member. Mr. Wirasendjaja is in charge of malaria control activities and is, of course, well known to many. Mr. Robinson also reports that MARVIN KRAMER, former manager of the Tulare District, California, has now commenced his duties as Assistant Manager in the Alameda County District.

DR. JOHN T. MORRISON, a member and President of the Morris County Mosquito Extermination Commission from 1938 to 1948 and President of the New Jersey Mosquito Extermination Association in 1942, has reapplied for membership in the American Mosquito Control Association. Prior to the war Dr. Morrison was employed with the Commonwealth Fund in New York City and was instrumental in the development of 15 community hospitals specializing in organization, personnel and development of procedures, resulting in high calibre community service. After a tour of duty with the Army, he returned to the Commonwealth Fund. In 1948 he became associated with the United Mine Workers of America, Welfare and Retirement Fund pursuing the same specialty for a specific group, the mine workers and their dependents. In this connection Dr. Morrison now serves as Assistant Executive Medical Officer.

The services provided by the Welfare and Retirement Fund approximate 50 million dollars per year for hospital and medical services in 45 states and Alaska. Ten hospitals are now under construction of which Dr. Morrison is Chairman of each Board of Directors. With all this John is still a mosquito man at heart and sends his best regards to his many friends. His address is United Mine Workers of America, Welfare and Retirement Fund, 907 Fifteenth Street, N.W., Washington, D. C.—R. L. Vannote.

TRAVIS E. MCNEEL, REPORTS SOME VERY INTERESTING PROBLEMS AND ACCOMPLISHMENTS IN THE PHILIPPINES, in a recent letter from the I.C.A. mission to that Republic. Mac has uncovered filariasis in Mountain Province, which a sample survey showed to be 29 percent positive. The problem is that the known vectors are very rare up there. A further survey of the mosquito

population to isolate the possible new vector was instituted. In malaria control, the program is beginning to pay off in a big way. In the index areas, smears have shown that malaria has been reduced as much as 50 percent. In Mindoro, traditionally highly malarious, even though some home owners refused to have their houses sprayed, only 3 infants were found to be positive. Mac reports that they are comparing DDT and dieldrin in Northern Luzon in 4 areas. having about 10,000 people each. The test is about 10 months old and as yet no infants have been found positive for malaria in any of the sprayed areas, while the check is one percent above the base line data. He adds, stoutly, "We have good base line data too." All who know Mac will be sure of that. A later note adds the information that they have trained 450 men in malaria control techniques for the Philippine Government and three groups of students from foreign countries. In addition, 25 Philippine Army malaria control personnel took part in a 90 day training course.

HERBERT F. SCHOOF WAS REPORTED BY THE SAVANNAH (GEORGIA) *Morning News* to be one of the speakers at a meeting on 26 July sponsored by the Council of Community Associations to discuss means and methods of promoting a mosquito control program in Chatham County.

BILL BICKLEY TRANSMITS A CLIPPING FROM THE SPRINGFIELD (KENTUCKY) *Courier-Journal* WHICH REPORTS AN INVASION IN EARLY JULY OF SALT-MARSH MOSQUITOES in Western Kentucky. "The invasion of salt-marsh mosquitoes into parts of Western Kentucky is threatening to force some people from their homes," the newspaper quoted a local resident, perhaps a bit too luridly, and added, "One farmer told Judge Slaton he has kept his cattle in his barn for six or seven weeks. The farmer 'can't drive 'em out' into his mosquito-infested pastures, the judge said he was told." Local health authorities said that the mosquitos seemed to be breeding mainly in pools of water connected with mining operations, although these pools are not generally salty so much as acid or brackish. If the mines were indeed to blame for the invasion, they were suffering for it. The report closed with the statement that at least one strip-mine operator said he might have to stop operations because workers were too busy swatting mosquitoes to attend to their jobs.

WHO'S WHO IN THE AMERICAN MOSQUITO CONTROL ASSOCIATION. . . .

PAUL RUSSELL, known to all workers in mosquito control throughout the world, was born on 12 August 1894 and received his A.B. from Boston University in 1916. His M.D. came from Cornell in 1921 and in 1929 he added an M.P.H. from Harvard. After interning in Bellevue Hospital from 1921 to 1923, he went with the Rockefeller Foundation, with which institution he has been identified ever since. He directed the Straits Settlements sanitation campaign from 1926 to 1928, was chief of Malaria Section of the Bureau of Science in Manila from 1929 to 1934, and his memory is still green in the hearts of his coworkers there. In 1935, he was transferred to Madras, India, where he remained until 1939. He has been consultant to the Public Health Service and the U. S. Army Surgeon General since 1947 and is the U. S. Member and chairman of the Expert Committee on Malaria with W.H.O. His military service extended through World War I and again, as a member of the Medical Service, U. S. Army, from 1943 to 46, when he left with the rank of Colonel. He is a Fellow of the Public Health Association, American Association for the Advancement of Science, American Medical Assoc., National Malaria Society and the Academy of Tropical Medicine and an honorary fellow of the Royal Society of Tropical Medicine and Hygiene. He has often served as consultant and in congresses on chronic tropical disease situations, as is noted in the press from time to time. His present address, aside from the Rockefeller Foundation in New York City, is North Edgecomb, Maine.

FRANCISCO J. DY, Director of the Regional Office of WHO, in Manila, was born on 17 September 1912 in that same city and received his M.D. from the University of the Philippines in 1937. In 1942, he received his M.P.H. from Johns Hopkins just in time to serve in the Pacific War, with the 5th Air Force, the Hq. Far East Air Forces and GHQ of USAFFE, his last military assignment being as Deputy Chief Public Health Officer in MacArthur's Headquarters. He was discharged from the Army in 1945 as a Lt. Colonel and became a commissioned officer instead in the U. S. Public Health Service as a Senior Surgeon. As a consultant in malaria, he was instrumental in the progress of control during the days of the rehabilitation and was a consultant also in the work being done by the U. S. Corps of Engineers in the military areas. In 1950 he became Professor of Malariology in the University of the Philippines, a position he held until he was called to be Deputy Chief of the Malaria Section, WHO. He has received numerous awards, including the Legion of Merit (US) with oak leaf cluster, and the Distinguished Service Star of the Philippine Government.

ROBERT L. VANNOTE, charter member and first president of the American Mosquito Control Association, was born 11 November 1907 in Hasbrouck Heights, N. J., and had his undergraduate training in engineering at Cornell. He commenced his mosquito control training early, being a seasonal inspector and check inspector in Bergen County, New Jersey, during the years 1923 to 27, inclusive. In 1928 he began a two-year stint as senior inspector and then moved on

to Morris County where he has been Superintendent and Secretary (Director) ever since. During the war he was Assistant to the President of Newark College of Engineering as Head of the Industrial Relations Department and Armed Services Representative in the War Training Program for the U. S. Office of Education. He was also a member of the Board of Consulting Engineers of the Newark Defense Council. As President of R. L. Vannote, Inc., he is active in insect control and finds time also to act as a member of the N. J. Legislative Committee on Revision of Drainage Legislation and as a consultant in mosquito control to several organizations. He is also a member of the Entomological Society of America, the Cornell Club and the New Jersey, Florida and Virginia Mosquito Control Associations. He says he still has time to go camping and fishing, or maybe he just reads the magazines about them. At any rate Bob admits they're his hobbies.

ALLEN S. WEST, who recently returned to Canada after a year's assignment at Camp Detrick, Md., was born in Worcester, Massachusetts on 13 August 1909 and received his B.Sc. from the University of Massachusetts in 1931. His Ph.D. came in 1935, from Yale, after which he served for four years in Arizona and California with the Division of Forest Insects of the U. S. Department of Agriculture. From 1939 to 1946 he was Professor of Forest Entomology at the University of New Brunswick, although the last three years of this period were served as a Captain in the Chemical Service of the Canadian Army. In 1946 he became Associate Professor and in 1949 Professor of Zoology at Queen's University, Kingston, Ontario. During his leave of absence at Camp Detrick, he was Deputy Chief of the Entomology Branch of the Allied Sciences Section; since 1954 he has been a member of the Defence Research Board of Canada. Al lists his hobbies as "gardening, recorder and reading." We assume the "recorder" is the musical instrument and not the tape machine. In either case, aren't there some possibilities here for the next meeting of the A.M.C.A.?

DICK PETERS, the Association's latest President, whose modesty on his Who's Who form caused us to omit him last issue, kept us on tenterhooks this time too, but we stop the presses to report that he was born in Oakland, California, in 1915, one of twins, as we have all been bafflingly aware at one time or another. Dick says Bob is the working half and he (Dick) is the talking half. (Bob is Manager of the Lodi Mosquito Abatement District, but we'll go into him later).

Dick graduated from the University of California in 1937, a proud student of Professor William B. Herms, and spent 1938 studying Public Health and Sanitation as a neophyte in Solano. In 1939 and 1940, Dick was Vital Statistician and Coördinator of Sanitation for Monterey County and in 1941 and 1942 he was Mosquito Control Officer for the Bureau of Sanitary Engineering of the California State Health Department. 1942–43–44 and 1945 were passed as one of Uncle Sam's many, devoted and competent Sanitary Corps Officers in the Army, from which Dick emerged as a Major. Returning to the State Health Department, Dick says he "found," by which he means "helped create," an awakening interest in a vigorous mosquito control program. From Mosquito Control Specialist in 1946, Dick went on to Senior Vector Control Specialist and in 1951 he was appointed as Chief of the Bureau of Vector Control of the California State Department of Public Health, a position he has filled with brilliance ever since.

WILLIAM F. RAPP, JR., SENDS IN AN INTERESTING BIT OF INFORMATION FROM NEBRASKA. "The citizens of the North Platte Valley of Nebraska," he writes, "are becoming interested in having legislation which will permit them to form a mosquito abatement district. This work is spearheaded by Mayor W. L. George of Bayard, Nebraska. This area of Nebraska is almost entirely under irrigation, and between the seepage from the ditches and the practice of flooding pastures, produces a terrific population of mosquitoes, principally *Culex tarsalis* and *Aedes dorsalis*.

"Recently, at Bayard, *Aedes dorsalis* were biting at the rate of 240 per hour, and several years ago personnel of the United States Public Health Service recorded a biting rate of 300 per hour at Mitchell."

ON MAY 26, 1955, 44 PEOPLE GATHERED AT GIANT CITY STATE PARK LODGE in southern Illinois for the Southern section meeting of the Illinois Mosquito Control Association. This was the third meeting sponsored by the Illinois Mosquito Control Association this year. The first was at Urbana on February 23 and 24, the second was a training seminar on May 23 and 24 in cooperation with the South Cook County Abatement District and other abatement districts in the Chicago area.

The highlights of the southern section meeting were discussions of the relationship with fishlife to mosquito control by Dr. Earle Lyman of the Southern Illinois University; granular insecticides and other insecticides and larvicides by Mr. Kent Littig of the Public Health Service, CDC, Atlanta, Georgia; mosquito research programs by Professor W. M. Horsfall of the University of Illinois. All southern Illinois mosquito abatement districts were represented at this meeting as well as a number of people from industry and cities.

Proceedings of the Urbana meeting have been prepared and are available in limited quantity from the Illinois Department of Public Health, Springfield, Illinois. J. D. Williams, Secretary-Treasurer, Illinois Mosquito Control Association.

Has Anybody Had a Letter from Uncle Harry Stage? If you have, please send it along to *News and Notes* (with a note, too, about yourself). Harry seems to have stricken us off his list and we miss those postcards from all those exotic places.

Section D, Medical and Veterinary Entomology, of the Entomological Society of America, reminds us that they are looking for good exhibits of scientific material for display at the meetings to be held 28 November through 1 December, in Cincinnati, Ohio. Dr. Roy Rings, an old-time mosquito control man from World War II days, has achieved a goodly space for the show. In addition, the section will be addressed by Dr. James Crow, authority on the genetics of insect resistance to insecticides, and by Dr. Max Day, of Canberra, Australia, on Insect Transmission of Myxomatosis. This mosquito-borne disease of rabbits caused quite a little flurry recently in France when it threatened to wipe out the domesticated hare, an important food source.

Captain Wesley Nowell (Fourth Epidemiological Flight, A.P.O. 633, New York, N. Y.) writes that he has been traveling considerably in Europe and Africa. He generously adds an "offer . . . to follow through on any reasonable request from A.M.C.A. members for information, contacts, or publications pertaining to entomology in European countries."

After News and Notes for September Was All Set in Galley We Had a Letter From Uncle Harry Stage Ourselves. Harry lightly dismisses the nightly alarums in Saigon with the remark that "the gaining of freedom and the birth of a new nation are always painful" and goes on to say that the Viet Namese need much help from us and that his malaria control men show their gratitude by being eager to give their best to the work. Harry spent two weeks recently on an island which has a name that looks like Isle de Phu Quoc, in the Gulf of Siam, from which he collected some interesting mosquitoes in pitcher plants and has sent them on to Ernestine Thurman for identification.

Whereas, the Great Creator has seen fit to call home our respected associate and friend, Karl Dean Hardy

Be it Therefore Resolved that the following tribute of respect be recorded upon the minutes of the Salt Lake City Mosquito Abatement Association, of which he was a faithful Board member for 28 years and 4 months.

KARL DEAN HARDY

Congenial and Understanding
Honest and Intelligent
True to Any Trust
Interested in the Welfare of Others
Truly, *A Man Among Men*

Fellow members of the Board, and the citizens of Salt Lake City generally, appreciate fully the unselfish service he has rendered in Mosquito Abatement work and shall miss his fine influence and wise counsel.

Born	Elected to Board of Trustees	Deceased
March 29, 1883	February 16, 1927	June 22, 1955

(The above copy of the resolution on the death of Mr. Hardy was sent in by Don M. Rees, who added further, "Mr. Hardy was well known to mosquito workers throughout the country and has attended numerous New Jersey meetings and meetings of the American Mosquito Control Association.")

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO CONTROL WORKERS AND MALARIOLOGISTS

HELEN SOLLERS

Plant Pest Control Branch
Agricultural Research Service
United States Department of Agriculture

AERIAL APPLICATION

HIRST, J. M. 1955. Aerial mosquito control. Pest Control 23(4):9–10, 12.

YEO, D. 1954. Aircraft applications of insecticides in East Africa. IX. Further experiments on the deposition in open country of a course aerosol released from an aircraft. Bul. Ent. Res. 45(4):745–749, 4 refs.

LARVICIDES

ORI, S. 1954. Mosquito control works in Nagasaki City. I. Basic control experiment and its application in the graveyard area. Part I. Nagasaki Med. Soc. Jour. 29(12):1025–1033, 5 refs.

VARIOUS TYPES OF CONTROL

ANONYMOUS. 1954. The mosquito's doom. Monsanto Mag. 34(4):3–5.

ADAMS, C. V. 1955. Side-lights of mosquito control. Turtox News 33(1):30–32.

AFRIDI, M. K. 1954. The evolution of malaria control measures. Pakistan Jour. Health 4(1):1–9.

ALAMEDA COUNTY MOSQUITO ABATEMENT DISTRICT. 1954. Twenty-fourth annual report. 20 pp.

ANNECKE, D. H. 1954. Use of dieldrin in control of malaria. East African Med. Jour. 31(11): 491–494.

BOMBAY. DIRECTORATE OF PUBLICITY. 1954. War on malaria by student-volunteer army. Bombay, 16 pp.

DAVIDSON, G. 1955. The principles and practice of the use of residual contact insecticides for the control of insects of medical importance. Jour. Trop. Med. 58(4):73–80, many refs.

DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT. 1954. Twenty-seventh annual report, 1954. Lyons, Ill., 20 pp.

ENTOMOLOGY RESEARCH BRANCH. 1955. Mosquitoes. How to control them on your property. U. S. Dept. Agr. Leaf. 386, 4 pp.

GRISHCHENKO, A. K. 1954. Control of malaria in the Kurangensk district in the Krasnodarsk region. Med. Parazit. i Parazit. (Moskva) 3: 230–233. In Russian.

INDIANA. PURDUE UNIVERSITY. DEPT. OF AGRICULTURAL EXTENSION. 1954. Mosquito control in cities and communities. Purdue Univ. Agr. Ext. Mimeo. E-26, revised, 5 pp.

IYENGAR, M. O. T. 1954. Practical aspects of malaria control. SPC Quart. Bul. (New Caledonia) 4(2):13, 16.

KNIPE, F. W. 1954. The place and duties of an engineer in a malaria control programme in India. Irrig. and Power 11(3):421–425.

KUBYCHINSKII, B. S. 1954. Something new in mosquito control under natural conditions. Med. Parazit. i Parazit. (Moskva) 1:60–61. In Russian.

MOROZVSKAIA, M. I., and COWORKERS. 1954. Antimalarial measures in the building area of Kakhooskaia Hydro-Electric Station. Med. Parazit. i Parazit. (Moskva) 1:61–66. In Russian.

OLAVARRIA, J. 1954. La gran campana antipaludica de Cerdana de 1946 a 1950. Rev. de Sanid. e Hig. Pub. (Madrid) 28(7/8):597–599. In Russian.

POZDEEV, T. S. 1954. On the effectiveness of benzene hexachloride action in dusting the resting places of the malarial mosquitoes at different times. Med. Parazit. i Parazit. (Moskva) 1:54–57. In Russian.

RAINEY, M. B. 1955. Good irrigation vital in mosquito control. Agr. Engin. 36(3):185–187, 191, 7 refs.

SUFFOLK COUNTY MOSQUITO CONTROL COMMISSION. 1954. Report. Yaphank, N. Y. 16 pp.

INSECT RESISTANCE

ASCHER, K. R. S. 1955. Insect-resistance to dieldrin. A survey of the literature. Riv. di Parassitol. 16(1):31–40, many refs.

LIVIDAS, G. 1955. Resistance of anophelines to chlorinated insecticides in Greece. *Mosquito News* 15(2):67–71, 10 refs.

RAJAGOPALAN, N., VEDAMANICKAM, J. C., and RAGHUPATHI, R. S. 1954. Development of resistance to B. H. C. by *C. fatigans* in the course of a larval control programme. Natl. Soc. India for Malaria and Other Mosquito-Borne Dis. Bul. 2(6):211–213.

REPELLENTS AND ATTRACTANTS

DOWLING, M. A. C. 1955. Insect repellents and miticides. Jour. Roy. Army Corps 101(1): 1–15, 62 refs.

THOMPSON, R. P., and BROWN, A. W. A. 1955. The attractiveness of human sweat to mosquitoes and the role of carbon dioxide. *Mosquito News* 15(2):80–84, 11 refs.

INSECTICIDES AND CHEMICALS

Barragat, P. 1954. Anormalidades na relação entre a concentração em isomero gama do hexachlorociclohexano e a sua ação inseticida. Rev. Brasil. de Malariol. 6(2):275–280.

Burchfield, H. P., and Wilcoxon, F. 1954. Comparison of dosage-response and time-response methods for assessing the joint action of antimetabolites. Boyce Thompson Inst. Contrib. 18(1):79–84, 2 refs.

Casida, J. E. 1955. Toxicity of aromatic acids to the larvae of the mosquito *Aedes aegypti* L. and the counteracting influence of amino acids. Biochem. Jour. 59(2):216–221, many refs.

Davidson, G. 1955. The principles and practice of the use of residual contact insecticides for the control of insects of medical importance. Jour. Trop. Med. 58(3):49–56. (To be cont'd.)

Morrill, A. W., Jr., and Wesley, C., Jr. 1955. Studies on insecticidal fog generation for military use. II. Solvents for insecticidal fog formulation. *Mosquito News* 15(2):86–90, 10 refs.

Rachou, R. G., Ferreira, M. O., and Lima, M. M. 1954. Preliminary results of a field test for comparison of efficacy of three insecticides and residual effect applied to the interior of houses to control *Culex fatigans*. Rev, Brasil. de Malariol. 6(2):159–172. (Includes BHC, DDT, dieldrin.)

Ricciardi, L., and Paulini, E. 1954. Investigations on the mode of action of DDT and BHC against *Culex fatigans*. Rev. Brasil. de Malariol. 6(2):285–288.

Storrs, E. E., and Burchfield, H. P. 1954. Joint action of binary mixtures of insecticides. Boyce Thompson Inst. Contrib. 18(1):69–78, 8 refs.

EQUIPMENT

Chamberlin, J. C., Getzendaner, C. W., Hessig, H. H., and Young, V. D. 1955. Studies of airplane spray-deposit patterns at low flight levels. U. S. Dept. Agr. Tech. Bul. 1110, 45 pp., 5 refs.

Jones, G. P. 1955. Jeep mounted mist blower. *Mosquito News* 15(2):71–73.

Morrill, A. W., Jr., Hahl, R. G., and Lotze, K. A. 1955. Studies on insecticidal fog generation for military use. I. Military research on a non-thermal aerosol fog generator. *Mosquito News* 15(2):85–86.

Nowell, W. R. 1955. The L-20 as a vehicle for aerial dissemination of insecticide by the U. S. Air Force. *Mosquito News* 15(2):73–80.

BIOLOGY AND ECOLOGY

Dabrowska, E., and Tarwid, K. 1954. Remarks on the occurrence of forest mosquito associations in the Kampinos Forest. Ekol. Polska 2(2):203–214. English Summary.

D'Alessandro, G. 1954. Study of a mountain habitat of *Anopheles labranchiae* in Sicily. Riv. di Parassitol. 15(4):361–372.

Ishii, N., Nakayama, A., and Ishii, Y. 1954. Biological observations on the mosquito, *Aedes albopictus*. Yokohama Med. Bul. 5(4):275–281.

Kershaw, W. E., Chalmers, T. A., and Lavoipierre, M. M. 1954. Studies on arthropod survival. I. The pattern of mosquito survival in laboratory conditions. Ann. Trop. Med. and Parasitol. 48(4):442–450.

Kirchberg, E. von, and Petri, K. 1955. Über die zusammenhange zwischen verbreitung und überwinterungsmodus bei der steckmüke *Aedes (Ochlerotatus) rusticus* Rossi. (Beiträge zur kenntnis der Culicidae III). Ztschr. f. Angewandte Zool. 6(1):81–94, many refs.

Kuhlhorn, F. 1954. Beitrag zur verbreitung und oekologie oberbayerischer culiciden (*Culex, Theobaldia, Aedes*/Dipt.). Nachrbl. der Beyer Ent. 3(4):33–35; 3(5):47–50; 3(6):59–61, 10 refs.

Lea, A. O., Knierhim, J. A., Dimond, J. B., and DeLong, D. M. 1954. A preliminary note on egg production from milk-fed mosquitoes. Ohio Jour. Sci. 55(1):21–22.

Mariani, M., and Cefalu, M. 1954. On the manner of overwintering of *Anopheles labranchiae* in Sicily under extra-domestic conditions of life. Riv. di Parassitol. 15(4):485–488.

Newkirk, M. R. 1955. On the eggs of some man-biting mosquitoes. Ent. Soc. Amer. Ann. 48(1/2):60–66, 15 refs.

Ori, S. 1954. Seasonal prevalence of mosquitoes collected in a hen house at Nagasaki City. Nagasaki Med. Soc. Jour. 29(12):1038–1042, 8 refs. English Summary.

————, and Shimogama, M. 1953. Seasonal prevalence of mosquitoes in cow-shed at Nagasaki City. 1. The results obtained in 1952. Nagasaki Med. Soc. Jour. (Nagasaki Igakkai Zassi) 28(9): 1020–1026, 10 refs. English Summary.

Terzian, L. A., and Stahler, N. 1954. The effect of age and sex ratio on the mating activity of *Anopheles quadrimaculatus* Say. Jour. Expt. Zool. 127(2):389–396.

BEHAVIOR

Bekku, H. 1953. Studies on the diurnal [feeding] activity of bush-inhabiting mosquitoes. I. Nagasaki Med. Soc. Jour. 28(9):1027–1035, 6 refs. English Summary.

———— 1954. Studies of the feeding activity of bush-inhabiting mosquitoes. II. Nagasaki Med. Soc. Jour. 29(12):1043–1054, 13 refs. English Summary.

Olsen, C. E. 1955. How a mosquito bites you. Canad. Nature 17(2):56–61.

Omori, N. 1954. On the swarming of *Culex pipiens pallens*. Japan. Jour. Sanit. Ent. 4 (Sp. Ed.):342–350. In English.

MORPHOLOGY AND PHYSIOLOGY

BEKKU, H. 1953. On the amount of blood taken up by a female mosquito of *Culex pipiens pallens* Coquillett. Nagasaki Med. Soc. Jour. 28(9):1036–1037. In English.

CLARK, E. W., and BALL, G. H. 1954. The major inorganic constituents of whole bodies of adult *Culex tarsalis* and *Culex stigmatosoma*. Physiol. Zool. 27(4):334–341, 45 refs.

DAY, M. F. 1954. The mechanism of food distribution to midgut or diverticula in the mosquito. Austral. Jour. Biol. Sci. 7(4):515–524.

KOZHEVNIKOVA, S. M. 1954. Autumnal physiological condition of *Anopheles maculipennis messae* females in Stalingrad in the years 1949–1951. Med. Parazit. i Parazit. (Moskva) 1:26–30.

LAL, R. 1953. Notes on the effect of temperature on the developmental stages of *Anopheles subpictus* Grassi and *Anopheles stephensi* Liston. Indian Jour. Ent. 15(2):97–106, 27 refs.

WOKE, P. A. 1955. Deferred oviposition in *Aedes aegypti* (Linnaeus) (Diptera: Culicidae). Ent. Soc. Amer. Ann. 48(1/2):39–46, 14 refs.

DISTRIBUTION

BLANTON, F. S., GALINDO, P., and PEYTON, E. L. 1955. Report of a three year light trap survey for biting Diptera in Panama. *Mosquito News* 15(2):90–93.

CARPENTER, S. J., and LACASSE, W. J. 1955. Mosquitoes of North America. Berkeley, Calif. 386 pp., over 750 refs.

DURET, J. P. 1954. Nuevos datos sobre *Culex* Argentinos (Diptera-Culicidae). Rev. Sanid. Mil. Argent. 53(2):242–244.

GALINDO, P., and BLANTON, F. S. 1955. An annotated list of the *Culex* of Panama (Diptera, Culicidae). Ent. Soc. Wash. Proc. 57(2):68–74, 17 refs.

IYENGAR, M. O. T., and MENON, M. A. U. 1955. Mosquitoes of the Maldive Islands. Bul. Ent. Res. 46(1):1–10, 13 refs.

MATTINGLY, P. F., and BROWN, E. S. 1955. The mosquitoes (Diptera: Culicidae) of the Seychelles. Bul. Ent. Res. 46(1):69–110, many refs.

OMORI, N. 1953. A consideration on the distribution of some anopheline mosquitoes. Nagasaki Med. Soc. Jour. 28(9):1016–1019, 3 refs. English Summary.

POLIAKOVA, Z. P. 1954. Distribution of *Anopheles maculipennis* in Voroshilovgrad Region. Med. Parazit. i Parazit. (Moskva) 4:359. In Russian.

REES, D. M., and NIELSON, L. T. 1955. Additional mosquito records from Utah (Diptera: Culicidae). Pan-Pacific Ent. 31(1):31–33.

SENEVET, G., and ANDARELLI, L. 1954. Presence de *Aedes punctor* Kirby, 1837 en Algerie. Inst. Pasteur d'Algerie Arch. 32(4):309.

See also Floch and Fauran; Hamon; Hamon and Rickenbach; Peyton, Galindo and Blanton under Taxonomy.

TAXONOMY

BELKIN, J. N. 1955. The *Tripteroides caledonica* complex of mosquitoes in Melanesia (Diptera: Culicidae). Pacific Sci. 9(2):221–246.

FLOCH, H., and FAURAN, P. 1954. Nouveaux *Culex* en Guyane Francaise: *Culex (Aedinus) amazonensis* Lutz et *Culex (Melanoconion) idottus* Dyar, *Culex (Melanoconion) vidali* n. sp. Inst. Pasteur Guyane Francaise Arch. 15(333):1–7.

GIL COLLADO, J. 1954. Orientaciones actuales sobre la sistematica del complejo *maculipennis* del género *Anopheles*. Med. Colonial (Madrid) 24(3):219–230.

HAMON, J. 1954. Contribution a l'etude des culicides d'Afrique Occidentale. Description de *Ficalbia (Ficalbia) grenieri* sp. n. Soc. de Path. Exot. Bul. 47(6):835–839, 3 refs.

———, and RICKENBACH, A. 1954. Contribution a l'étude des culicides d'Afrique Occidentale. Description d'*Aedes (Aedimorphus) mattinglyi* sp. n., *Aedes (Banksiella) jamoti* sp. n. Notes complementaires sur *Aedes (Aedimorphus) stokesi* Evans, *Aedes (Banksinella) bolensis* Edwards. Soc. de Path. Exot. Bul. 47(6):930–941, 13 refs.

KOMP, W. H. W. 1955. Notes on the larva of *Haemagogus janthinomys* Dyar. (Diptera: Culicidae). Ent. Soc. Wash. Proc. 57(3):137–138, 7 refs.

LAIRD, M. 1955. Abnormalities exhibited by mosquito larvae collected in Tonga. Bul. Ent. Res. 46(1):185–188.

LAMBRECHT, F. L. 1954. *Anopheles (Christya) implexus,* Theobald; description de la variété locale de la vallée du Mosso (Urundi). Rev. de Zool. et de Bot Africaines 50(3/4):204–209, 4 refs.

LUNGSTROM, L. 1955. Additional observations on the recognition features of the *Culex tarsalis* larva and pupa (Culicidae: Diptera). Kans. Acad. Sci. Trans. 58:68–74, refs.

MATTINGLY, P. F. 1954. Notes on the subgenus *Stegomyia* (Diptera, Culicidae), with a description of a new species. Ann. Trop. Med. and Parasitol. 48(3):259–270.

NEWKIRK, M. R. 1955. On the eggs of some man-biting mosquitoes. Ent. Soc. Amer. Ann. 48(1/2):60–66, 15 refs.

PEYTON, E. L., GALINDO, P., and BLANTON, F. S. 1955. Pictorial keys to the genera of Panama mosquitoes. *Mosquito News* 15(2):95–100, 13 refs.

RAFFAELE, G. 1954. On *Anopheles hispaniola* and related species of the *paramyzomyia* group. Riv. di Parassitol. 15(4):601–604.

SENEVET, G., and ANDARELLI, L. 1954. Le genre *Aedes* en Afrique du Nord. 1. Les larves. Inst. Pasteur d'Algerie Arch. 32(4):310–351, many refs.

Vermeil, C. 1954. Nouvelle contribution a l'étude du complexe *Culex pipiens* en Tunisie. Soc. de Path. Exot. Bul. 47(6):841–843, 4 refs.

WANSON, M., and BERTEAUX, M. 1954. La larve de l'*Anopheles mortiauxi* Edwards. Rev. Zool. et de Bot. Africaines 49(1/2):33–38, 5 refs.

TECHNIQUE

BRACEY, P. 1954. Urea-formaldehyde resin as a vehicle for semi-permanent insecticidal residues to control flies and mosquitoes. Symposium on Control of Insect Vectors of Disease 1:344–393, 30 refs.

CLYDE, D. F., and SHUTE, G. T. 1955. A technique for the investigation of mosquito feeding preferences on man. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):64–67, 5 refs.

STAUBER, L. A. 1954. Application of electrophoretic techniques in the field of parasitic diseases. Expt. Parasitol. 3(6):544–567, many refs. (Includes malaria).

WOLFINSOHN, M., and GALUN, R. 1953. A method of determining the flight range of *Aedes aegypti* (Linn.). Res. Council Israel Bul. 2(4): 433–436, 4 refs.

DISEASES

FAUST, E. C. 1955. Animal agents and vectors of human disease. Philadelphia. 660 pp.

JACOTOT, H., TOUMANOFF, C., VALLEE, A., and VIRAT, B. 1954. Sur le rôle des moustiques dans la transmission de la myxomatose. Compt. Rend. Acad. Sci. (Paris) 239(11):909–911.

———— 1954. Transmission experimentale de la myxomatose au lapin par *Anopheles atroparvus* et *Anopheles stephensi*. Inst. Pasteur Ann. 87(5):477–485, 8 refs.

KILHAM, L. 1955. Metastasizing viral fibromas of gray squirrels: pathogenesis and mosquito transmission. Amer. Jour. Hyg. 61(1):55–63.

LUMSDEN, W. H. R. 1955. An epidemic of virus disease in Southern Province, Tanganyika Territory, in 1952–1953. II. General description and epidemiology. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):33–57, 9 refs.

ROBINSON, M. C. 1955. An epidemic of virus disease in Southern Province, Tanganyika Territory, in 1952–1953. I. Clinical features. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):28–32, 11 refs.

STERK, V. V., TAHORI, A. S., and GOLDBLUM, N. 1954. Studies in the natural history of West Nile fever. 2. Transmission of West Nile virus by laboratory bred *Culex* mosquitoes. Israel Res. Council Bul. 4(2):207.

DENGUE

SABIN, A. B. 1955. Recent advances in our knowledge of dengue and sandfly fever. Amer. Jour. Trop. Med. and Hyg. 4(2): 198–207.

ENCEPHALITIS

FRENCH, E. L., and REEVES, W. C. 1954. A group of viruses isolated from naturally infected mosquitoes collected in the Murray Valley area of Victoria and New South Wales. Jour. Hyg. 52(4):551–562.

HESS, A. D. 1954. The work of the Logan Field Station in relation to water resources development. U. S. Pacific Southwest Fed. Inter-Agency Tech. Com. Min. Meeting 54–4:75–77. (Mimeo.)

MATHENY, W. J., JR. 1955. Avian encephalomyelitis in pheasants. Cornell Vet. 45(1):89–93.

ROSEN, L. 1954. Observations on *Dirofilaria immitis* in French Oceania. Ann. Trop. Med. and Parasitol. 48(3):318–328.

WENNER, H. A., MENGES, R. W., and CARTER, J. 1955. Sporadic bovine encephalomyelitis; a serologic survey of cattle in the Midwestern United States. Cornell Vet. 45(1):68–77.

FILARIASIS

DASSANAYAKE, W. L. P. 1954. A follow-up of 230 cases of bancroftian filariasis treated with hetrazan at the filariasis clinic at Dehiwala, Ceylon. Ann. Trop. Med. and Parasitol. 48(2):123–126.

IYENGAR, M. O. T. 1955. Filariasis investigations in New Caledonia. SPC Quart. Bul. (New Caledonia) 5(1):27–34.

JORDAN, P. 1954. Filariasis in the Southern Province of Tanganyika. East African Med. Jour. 31(12):537–542.

MCCARTHY, D. D., and FITZGERALD, N. 1955. Researches in western Samoa. III. Observations on filariasis. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):82–89, 7 refs.

RACHOU, R. G., DEANE, L. M., DAMASCENO, R. G., and LIMA, M. M. 1954. Correlation between the periodicity of microfilariae of *Wuchereria bancrofti* and the periodicity of frequency in houses of *Culex fatigans* in northern and southern Brazil. Rev. Brasil. de Malariol. 6(2):205–218, 2 refs.

RACHOU, R. G., FERREIRA, M. O., and LIMA, M. M. 1954. Investigation of Bancroft's filariasis in Florianopolis, capital of state of Santa Catarina. Rev. Brasil. de Malariol. 6(2):189–204.

ROBINSON, E. J., JR. 1955. A description of attempts to infect mosquitoes with avian filarial worms. Jour. Parasitol. 41(2):176–178, 3 refs.

ROSEN, L. 1955. Observations on the epidemiology of human filariasis in French Oceania. Amer. Jour. Hyg. 61(2):219–248, many refs.

SOUTH PACIFIC COMMISSION. 1954. Annotated bibliography of filariasis and elephantiasis. Part I. Epidemiology of filariasis in the South Pacific Region. Tech. Paper no. 65, 63 pp. Noumea, New Caledonia.

VON WINTER, H. 1955. "Tropische eosinophilie" als symptomarme filariasis. Tropenmed. und Parasitol. 6(1):99–105, refs.

WEBBER, W. A. F., and HAWKING, F. 1955. Experimental maintenance of *Dirofilaria repens* and *D. immitis* in dogs. Expt. Parasitol. 4(2): 143–164.

MALARIA

ARCHIBALD, H. M., and BRUCE-CHWATT, L. J. 1955. Sickling and malaria. Brit. Med. Jour. 4919:970.

AVALISHVILI, S. D., and INTSKIRVELI, T. P. 1954. Gravity of tertian malaria with prolonged incubation in the Adzharsk Soviet Republic. Med. Parazit. i Parazit. (Moskva) 3:219–226. In Russian.

BARANGER, P., and FILER, M. 1954. Recherches sur un antagonisme entre le sarcome de Rous et la malaria aviaire. Compt. Rend. Acad. Sci. (Paris) 238:2037–2039.

BATTAGLIA, A. 1954. Hemoterapia y paludismo. Dia Medico (Buenos Aires) 26(55):1499–1501.

BENAZET, F., SOHIER, R., DIGOUTTE, J. P., and SASSOT, P. 1954. Criteres diagnostiques du paludisme chez les Europeens repatries de zones d'endemic palustre. (Incidences médico-legales). Soc. de Path. Exot. Bul. 47(5):696–709, 5 refs.

BLACK, R. H. 1954. A malaria survey of the people living on the Minj River in the western highlands of New Guinea. Med. Jour. Austral. 41(20):782–787.

———— 1955. Comparison of the liver and spleen sizes in a community in Netherlands New Guinea suffering from malaria on a high degree of endemicity. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):62–63, 3 refs.

BRASS, W., FOY, H., TIMMES, G. L., and MOORE, R. A. 1955. Sickling and malaria. Brit. Med. Jour. 4908:285–286.

BUIANOVA, O. F. 1954. Anophelogenicity and malariogenic significance of ponds constructed in valleys. Med. Parazit. i Parazit. (Moskva) 1:66–70. In Russian.

DOLGOV, N. V. 1954. Results of work on liquidation of malaria as a mass disease. Med. Parazit. i Parazit. (Moskva) 3:234–238. In Russian.

DUKHANINA, N. N. 1954. New vernal cases of tertian malaria in the southern parts of the country. Med. Parazit. i Parazit. (Moskva) 3:203–211. In Russian.

EL'KINA, G. V., TSVETKOVA, E. N., and ZHUKOV, G. V. 1954. In regard to three-day malaria with prolonged incubation under conditions of the Samarkand. Med. Parazit. i Parazit. (Moskva) 4:350–351. In Russian.

GRINBERG, A. I. 1954. Tertian malaria with prolonged incubation in Kishinev. Med. Parazit. i Parazit. (Moskva) 3:216–219. In Russian.

HERRLICH, A. 1954. Malaria und ruhr in der gutachter-praxis. Ztschr. Ges. Inn. Med. 9(19/20): 989–992.

JAIN, R. S. 1954. Malaria hazards and the civil engineer. Irrig. and Power 11(4):506–514.

JOHNSON, D. R. 1955. "Operation Mercy." *Mosquito News* 15(2):93–94.

MACDONALD, G. 1955. Medical implications of the Volta River Project. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):13–24, 12 refs.

MACKERRAS, M. J., and SANDARS, D. F. 1954. Malaria in the Torres Straits Islands. So. Pacific Com. Tech. Paper 68, 27 pp.

MOLCHANOVA, L. A. 1954. Three-day malaria with prolonged incubation in Turkmenian SSSR. Med. Parazit. i Parazit. (Moskva) 4:352–353. In Russian.

PAMPANA, E. J. 1955. Malaria education is now a world problem. United Nations Rev. 1(10):14–16.

RAPER, A. B. 1954. Sickling and malaria. Brit. Med. Jour. 4897:1162–1163.

WHITE, L. G., and DOERNER, A. A. 1954. Functional and needle biopsy study of the liver in malaria. Amer. Med. Assoc. Jour. 115(7): 637–639, refs.

WILCOCKS, C. 1955. Summary of recent abstracts. III. Malaria. Trop. Dis. Bul. 52(3): 234–241; (4):317–328.

Malaria—Clinical Aspects

ARMAND, M., CATALOGNE, G. DE, and FRANCILLON, U. 1954. Note experience du paludisme et de la grossesse a la maternité de Chancerelles. Gaz. Med. France 61(20):1147–1148.

ARNOLD, J., and COWORKERS. 1954. Natural history of Korean *vivax* malaria after deliberate inoculation of human volunteers. Jour. Lab. and Clin. Med. 44(5):723–726.

BHOWMICK, S. K. 1954. An obstinate case of cerebral malaria. Indian Med. Assoc. Jour. 24(1): 61–62.

DOERNER, A. A. 1955. Functional and needle biopsy study of the liver in malaria. Amer. Med. Assoc. Jour. 155(7):637–639, 6 refs.

EDINGTON, G. M. 1954. Cerebral malaria in the Gold Coast African: four autopsy reports. Ann. Trop. Med. and Parasitol. 48(3):300–306.

GABALDON, A. 1955. Measurement of liver enlargement. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):91–92.

URCHS, O. 1954. Ein blutpositives malaria spatrezidiv (m. quatran). Munch. Med. Wschr. 96(49):1448–1449.

VON WEIL, R. 1955. Zur frage des einflusses des hohenklimas auf huhnermalaria bei blutinokulation mit *Plasmodium gallinaceum* Brumpt. Acta Trop. 12(1):53–66, 7 refs.

Malaria—Epidemiology

MONTILLIER, J. 1954. Un foyer de paludisme au Gourara: Heiha. Inst. Pasteur d'Algerie Arch. 32(3):255–265.

RACHOU, R. G., FERREIRA, M. O., LOBO, A. G. S., and PIRES, W. DA. 1954. General considerations

on the epidemiology of malaria in southern Brazil. Rev. Brasil. de Malariol. 6(2):177–188.

Malaria—Plasmodia

ADLER, S. 1954. The behavior of *Plasmodium berghei* in the golden hamster *Mesocricetus auratus* infected with visceral leishmaniasis. Roy. Soc. Trop. Med. and Hyg. Trans. 48(5):431–440.

BISHOP, A. 1954. The action of 2:4-diamino-6:7-diisopropylteridae upon *Plasmodium gallinaceum* and its relation to other compounds which are pteroylglutamic acid antagonists. Parasitology 44(3/4):450–464, 43 refs.

——— 1955. Problems concerned with gametogensis in Haemosporiidea, with particular reference to the genus *Plasmodium*. Parasitology 45(1/2):163–185, many refs.

BRAY, R. S. 1955. "Resistance of *Plasmodium falciparum* to pyrimethamine." Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):93–94, 2 refs.

DE OLEIVERA, M. XAVIER, and MEYER, H. 1955. *Plasmodium gallinaceum* in tissue culture observations after one year of cultivation. Parasitology 45(1/2):1–4, 10 refs.

DRAPER, C. C. 1954. The duration of residual immunity following spontaneous cure of *Plasmodium berghei* in rats. Parasitology 44(3/4): 338–341.

FAURE, A. 1954. Evolution de l'infection a *Plasmodium berghei* chez la souris dans le midi de la France. Soc. de Path. Exot. Bul. 47(6): 795–892, 7 refs.

FULTON, J. D. 1954. Cortisone and *Plasmodium berghei* infection in rodents. Ann. Trop. Med. and Parasitol. 48(3):314–317.

GALLIARD, J., LAPIERRE, J., and MURARD, J. 1954. Evolution de l'infection a *Plasmodium berghei* chez les rats nouveau-nes. Soc. de Path. Exot. Bul. 47(6):885–894, 24 refs.

GALLIARD, H., LAPIERRE, J., and GOLVAN, Y. 1954. L'hyaluronidase dans les infections à protistes sanguicoles et en particulier *Plasmodium berghei;* action comparee avec la phenylhydrazine; rôle et signification de la reticulocytose. Ann. de Parasitol. Humain. et Compar. 29(4):330–346, 12 refs.

GARNHAM, P. C. C., and COWORKERS. 1955. The pre-erythrocytic stage of *Plasmodium ovale*. Roy. Soc. Trop. Med. and Hyg. Trans. 49(2): 158–167, 20 refs.

GREENBERG, J., and TREMBLEY, H. L. 1954. The apparent transfer of pyrimethamine-resistance from the BI strain of *Plasmodium gallinaceum* to the M strain. Jour. Parasitol. 40(6):667–672.

JEFFERY, G. M., WILCOX, A., and YOUNG, M. D. 1955. A comparison of west African and west Pacific strains of *Plasmodium ovale*. Roy. Soc. Trop. Med. and Hyg. Trans. 49(2):168–175, 9 refs.

LEFROU, G., and MARTIGNOLES, J. 1954. Contribution à l'étude de *Plasmodium* des chimpanzes. Inoculation de *Pl. falciparum* human au chimpanze. Soc. de Path. Exot. Bul. 47(6):895–903, refs.

MYATT, A. V., COATNEY, G. R., HERNANDEZ, T., and GUINN, E. 1954. Effect of blood group on the prepatent period of inoculated vivax malaria. Amer. Jour. Trop. Med. and Hyg. 3(6):981–984.

NAIR, C. P. 1954. Animals in malaria research. Natl. Soc. India for Malaria and Other Mosquito-Borne Dis. Bul. 2(6):200–207, many refs.

ROBERTS, O. J. 1954. The effect of cortisone on *Plasmodium berghei* infections. Parasitology 44(3/4):438–445.

RODHAIN, J. 1954. Absence d'immunite croisee entre *Plasmodium berghei* et *Plasmodium vinckei* dans les infections chez les jeunes rats. Soc. de Biol. (Paris) Compt. Rend. 148(15/18):1519–1520.

ROLLO, I. M. 1955. "Resistance of *Plasmodium falciparum* to pyrimethamine." Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):94–95, 8 refs.

SERGENT, E. 1954. L'étude immunologique experimentale du paludisme a *Plasmodium berghei*. Inst. Pasteur d'Algerie Arch. 32(4):277–298, 70 refs.

TRAGER, W. 1954. Coenzyme A and the malaria parasite *Plasmodium lophurae*. Jour. Protozool. (Utica) 1(4):231–237, 22 refs.

VOLOVIK, R. A. 1954. Infection of *Aedes aegypti* mosquitoes from chickens infected with *Plasmodium gallinaceum* (period of incubation). Med. Parazit. i Parazit. (Moskva) 4:360. In Russian.

WEATHERSBY, A. B. 1954. The ectopic development of malaria oocysts. Expt. Parasitol. 3(6):536–543.

Malaria—Therapeutics and Antimalarials

ANONYMOUS. 1954. Estadistica de los dispensarios antipaludicos dependientes de la direccion General de Sanidad. Rev. de Sanid. e Hig. Pub. (Madrid) 28(7/8):600–625.

ANNECKE, D. H., and JACOBS, A. J. 1954. Daraprim as a malaria suppressant. East African Med. Jour. 31(12):543–547.

BEUTLER, E., DERN, R. J., and ALVING, A. S. 1954. The hemolytic effect of primaquine. III. A study of primaquine-sensitive erythrocytes. Jour. Lab. and Clin. Med. 44(2):177–184, 19 refs.

CHAUDHURI, R. N. 1954. Diagnosis and treatment of malaria. Indian Med. Assoc. Jour. 24(1): 11–17.

DELANNOY, A., and HUGON, J. 1954. Essai de prophylaxie antipaludique en milieu rural au moyen de pyrimethamine (daraprim). Soc. Belge Med. Trop. Ann. 34(4):397–405.

DERN, R. J., BEUTLER, E., and ALVING, A. S. 1954. The hemolytic effect of primaquine. II. The natural course of the hemolytic anemia and the mechanism of its self-limited character. Jour. Lab. and Clin. Med. 44(2):171–176.

FABIANI, G., and ORFILA, J. 1954. Action d'un treatment sulfamide sur le paludisme experimental de la souris blanche. Soc. de Biol. (Paris) Compt. Rend. 148(15/18):1390–1392.

——— 1954. Action du regime lacte sur le paludisme experimental de la souris blanche. Soc. de Biol. (Paris) Compt. Rend. 148(13/14):1239–1241.

FABRE, J., and JOIGNY, J. R. 1955. Un an de chimioprophylaxie par la flavoquine effectuée a pointe-noire (Moyan-Congo). Soc. de Path. Exot. Bul. 48(1):99–111.

KIKUTH, W. 1954. Modern malariatherapie und prophylaxe. Deut. Med. Wschr. 79(38): 1401–1403.

OKPALA, I., and MANWELL, R. D. 1955. Chemotherapy of avian malarias: III. Trial of certain standard antimalarials on *Plasmodium hexamerium* and *P. elongatum* malaria in ducks. Jour. Parasitol. 41(1):65–70, 3 refs.

RAY, A. P. 1954. Role of blood transfusion in liver injury due to *P. knowlesi* infection in monkeys. Natl. Soc. India for Malaria and Other Mosquito-Borne Dis. Bul. 2(6):213–214.

SCHNEIDER, J., MONTEZIN, G., and DUPOUX, R. 1954. Étude experimentale et clinique de l'activite antipaludique d'une association de deux schizonticides: la chloroquine et la pyrimethamine. Soc. de Path. Exot. Bul. 47(6):791–795, 5 refs.

SHAPER, A. G. 1955. Malaria therapy in the nephrotic syndrome. Brit. Med. Jour. 4922:1132–1135, 7 refs.

TAPAVICZA, T. VON. 1954. Malariatherapie mit resochin in losung. Med. Klin. (Berlin) 49(49): 1958–1963.

Malaria—Vectors

BIERDRAGER, J., and ROOK, H. DE. 1954. Health conditions in Netherlands New Guinea. Doc. Med. Geog. et Trop. 6(3):252–266.

CHUBKOVA, A. I., and AMBARTSUMIAN, M. 1954. Phenology of *Anopheles maculipennis* on the Leninakan Plateau. Med. Parazit. i Parazit. (Moskva) 1:20–25. In Russian.

RAO, V. V. 1954. Malaria vectors of India. V. *A. annularis* Van der Wulp, 1884. Natl. Soc. India for Malaria and Other Mosquito-Borne Dis. Bul. 2(6):191–199, 19 refs.

YELLOW FEVER

BONNEL, P. H., and DEUTSCHMAN, Z. 1954. La fievre jaune en Afrique au cours des années recentes. World Health Organ. Bul. 11(3):325–389. English Summary.

BRETEAU, H. 1954. La fievre jaune en Afrique-Occidentale Francaise; un aspect de la medicine preventive massive. World Health Organ. Bul. 11(3):453–481. English Summary.

CAMBOURNAC, F. 1954. L'infection amarile dans l'Angola et dans les iles de São Tomé et Principe. World Health Organ. Bul. 11(3):504–507.

DE LA GARZA BRITO, A. 1954. La fiebre amarilla. Bol. Sanid. Mil. (Mexico) 7(6):163–200.

LUMSDEN, W. H. R. 1955. Entomological studies, relating to yellow fever epidemiology, at Gede and Taveta, Kenya. Bul. Ent. Res. 46(1): 149–183, many refs.

MAHAFFY, A. F. 1954. The yellow fever situation in Africa. World Health Organ. Bul. 11(3): 319–324.

PRATES, M. D. 1954. État actuel des recherches sur la fievre jaune dans le Mozambique. World Health Organ. Bul. 11(3):500–503.

SOPER, F. L. 1955. La fiebre amarilla en movimiento. Diario Rur. 15(1235):12.

VELSICOL CORPORATION. 1954. Mosquito control with heptachlor. New York. 8 pp.

BIOGRAPHY AND HISTORY

GALLI, G. 1954. Brief aus Italien. Munch. Med. Wschr. 96(36):1044–1066. (Notes on work of Battista Grassi).

LITERATURE REFERENCES AND REVIEWS

SOLLERS, H. 1955. References to literature of interest to mosquito control workers and malariologists. *Mosquito News* 15(2)132–138.

See also South Pacific Commission under Filariasis and Wilcocks under Malaria.

SUBJECTS NOT COVERED BY OTHER HEADINGS

BERTRAM, D. S., and MCGREGOR, I. A. 1955. An effect of wind-direction on mosquito catches in a baited wooden hut used in the Gambia for trapping *Anopheles gambiae* and *A. melas*. Roy. Soc. Trop. Med. and Hyg. Trans. 49(1):11–12.

BROCKWAY, P. B. 1954. The eighth annual report of the Toledo area Sanitary District. Toledo. 8 pp.

FLOCH, H., and FAURAN, P. 1954. *Mansonia fasciolata* (Lynch Arribalzaga 1891) vecteur des oeufs de *Dermatobia cyaniventris* (Macquart 1840) en Guyane Française. Inst. Pasteur Guyane Française. Arch. 15(338):1–4.

LAIRD, M. 1955. Abnormalities exhibited by mosquito larvae collected in Tonga. Bul. Ent. Res. 46(1):185–188, 3 refs.

MUNCHBERG, P. 1954. Zur kenntnis der an culiciden (Diptera) schmarotzenden Arrenurus-larven (Hydracarina), sowie über die bedeutung dieser parasiten fur wirt und mensch. Ztschr. f. Parasitenk. 16(4):298–312.

RALBAG, E. D. 1954. Allergic urticaria in horses. Refuah Vet. 11(3):166–167. (From mosquito bites.)

ROUBAUD, E. 1954. Les larves lethales et leur signification dans le complexe *Culex pipiens*. Riv. di Parassitol. 15(4):621–638.

ROY, D. N., and BROWN, A. W. A. 1954. Entomology (Medical and Veterinary) including insecticides and insect and rat control. Calcutta, 2nd Ed. 413 pp. (Includes control of mosquitoes.)

SWELLENGREBEL, N. H. 1954. On *Anopheles plumbeus*. Riv. di Parassitol. 15(4):667–669.